The UNESCO COURIER

MAY 1993

INTERVIEW WITH CHARLES MALAMOUD

WATER OF LIFE

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E N C O U N T E R S

We invite readers to send us photographs to be considered for publication in this feature. Your photo should show a painting, a sculpture, piece of architecture or any other subject which seems to be an example of cross-fertilization between cultures. Alternatively, you could send us pictures of two works from different cultural backgrounds in which you see some striking connection or resemblance. Please add a short caption to all photographs.

SHADOW AND BRIGHTNESS

1992, watercolour (76 x 56 cm), by David Fujitsang

The work of David Fujitsang, a Chinese-born painter who divides his time between France and Asia, explores the possibilities of aesthetic and cultural cross-fertilization between the Orient and the Occident. As an artist, he writes, "I have chosen to be a 'bridge' rather than a 'fortress'. I prefer to work for cultural exchange and mixing, while remaining deeply humble in face of the world's creative richness."

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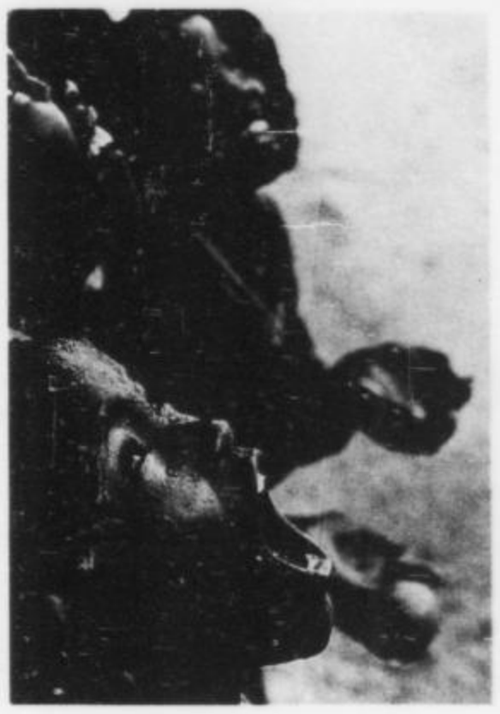

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Children in the rain in Lesotho.

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The UNESCO COURIER

46th year — Published monthly in 32 languages and in Braille

"The Governments of the States parties to this Constitution on behalf of their peoples declare,
"that since wars begin in the minds of men, it is in the minds of men that the defences of peace must be constructed ...
"that a peace based exclusively upon the political and economic arrangements of governments would not be a peace which could secure the unanimous, lasting and sincere support of the peoples of the world, and that the peace must therefore be founded, if it is not to fail, upon the intellectual and moral solidarity of mankind.
"For these reasons, the States parties ... are agreed and determined to develop and to increase the means of communication between their peoples and to employ these means for the purposes of mutual understanding and a truer and more perfect knowledge of each other's lives..."
EXTRACT FROM THE PREAMBLE TO THE CONSTITUTION OF UNESCO, LONDON, 16 NOVEMBER 1945

CHARLES MALAMOUD

talks to Tony Lévy

The French scholar Charles Malamoud, a specialist in the history and religions of India, describes in this interview the characteristics of Vedism and Hinduism, the great Indian religions, as revealed in their scriptures, rites and gods. A linguist by training, Malamoud started his career by studying the Sanskrit language before turning his attention to the Sanskrit classics and in particular to the patterns of thought underlying the oldest of these, the *Veda*. His published works include *Le Svâdhyâya, récitation personnelle du Veda, Taittirîya-Aranyaka II* (Boccard, Paris, 1977), *Lien de vie, nœud mortel, les représentations de la dette en Chine, au Japon et dans le monde Indien* (EHESS, Paris, 1988) and *Cuire le monde, Rite et pensée dans l'Inde ancienne* (La Découverte, Paris, 1989).

■ *Could you give an overview of the religious history of India?*

—If you leave aside the so-called Indus Valley civilizations, which are only known to us through rather scanty material remains that are difficult to interpret and even to date—I'm thinking of the sites of Moenjodaro and Harappa, from the third millennium B.C.—the religious history of India can be divided, in a very schematic way, into a "Vedic" period, from about 1500 to 500 B.C., and a "Hindu" period, starting in about 500 B.C. and continuing to the present day. These dates are intended as no more than a rough guide.

■ *Have other religions been involved?*

—Indeed. Two movements that took the form of a critique of Vedism and Hinduism made their appearance in India around 500 B.C. On the one hand there was Buddhism, a universally-minded religion (perhaps it would be more accurate to describe it as a world view) founded by the Buddha, a legendary figure who probably also really existed. Then there was Jainism, founded by another half-real, half-mythical figure, Mahavira, the Jina. Buddhism was to play a major cultural and philosophical role in India, but it disappeared almost entirely from the mainland by about 1000 A.D., while spreading to and taking root in the Himalaya region, Sri Lanka, and central, east and south-east Asia. Jainism was confined to India, where it has survived to the present day. Jainists now make up a small, prosperous and well-organized minority of the Indian population.

Another major event in Indian history was the conquest of much of the sub-continent by Muslims from Iran and Afghanistan, again around the year 1000 A.D. Once they had seized power, the conquerors made many converts—so many that Islam became one of the great religions of the subcontinent. After Independence and Partition in 1947, Pakistan, later to be divided in its turn when its eastern part became Bangladesh, was set up as an almost entirely Muslim state. But in the Indian Union itself, 10 per cent of the population are Muslim, which means more than 100 million people today. Another religion that came from outside is Christianity in its various forms, which began to be introduced into India by Europeans in the sixteenth century.

But the most ancient and characteristic religion of India, the one that can be said to be indigenous to the country, is the Vedic-Hindu complex. It has by far the greatest number of adherents, and it is the faith most closely linked to traditional Indian ways of thought and forms of social organization.

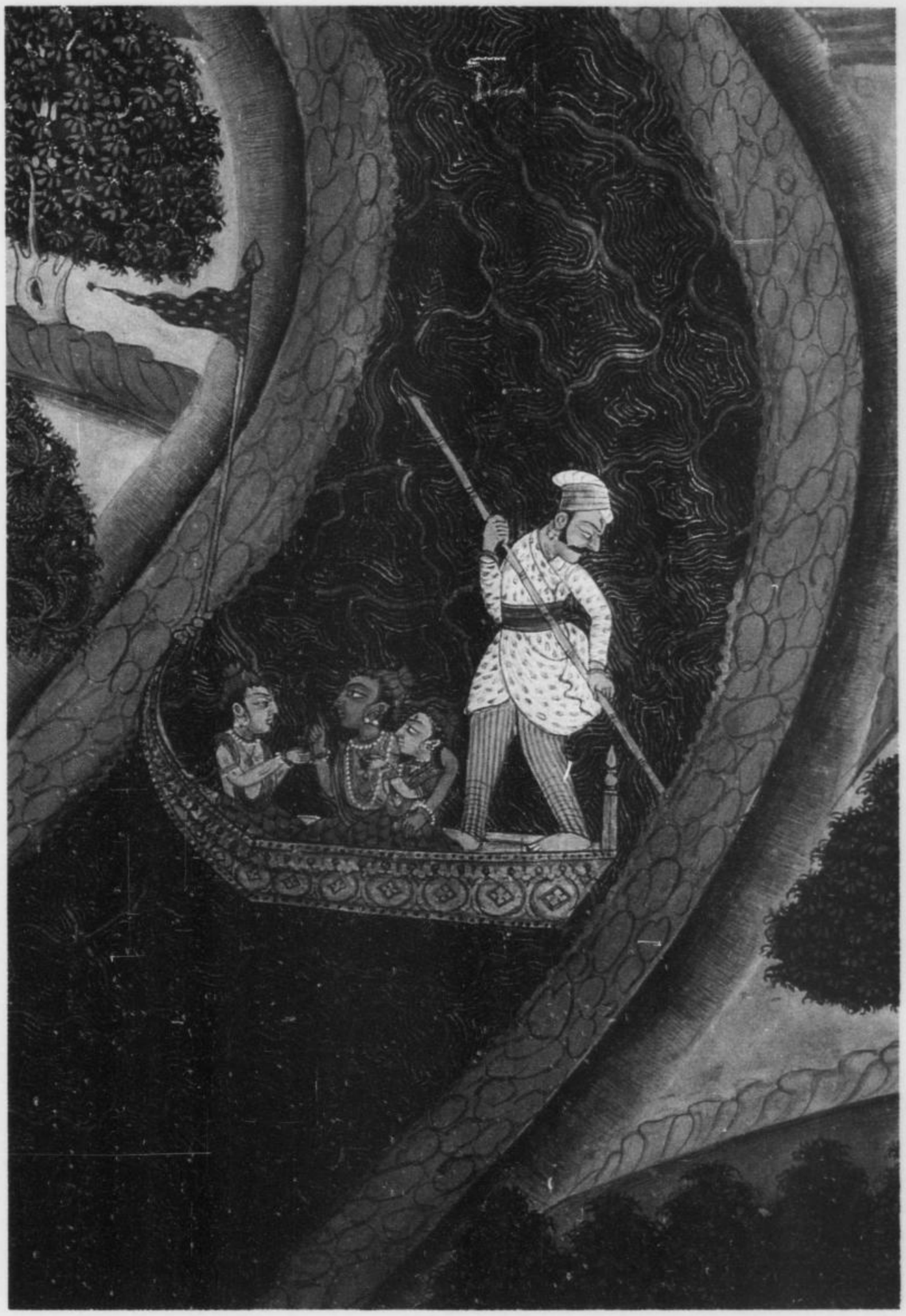
■ *How are Vedism and Hinduism linked?*

—Well, Vedism and Hinduism are two successive phases or aspects of the same religion rather than two separate religions. To put it another way, there was never a clean break between Vedism and Hinduism, for all their very obvious differences and even contradictions. There wasn't even a deliberate or consciously undertaken movement of radical reform. Even now in very orthodox circles, Vedism is still considered the source of Hinduism and its ultimate authority, as valid now as ever.

What's more, there is a third term in the vocabulary of historians of religion that underlines the continuity between Vedism and Hinduism. This is the word "Brahmanism". It has more than one meaning, referring both to the form of religion codified in the texts known as the *Brahmana*, which date from the end of the Vedic period, and also to the orthodox core of early Hinduism.

■ *Does each phase have its own scriptures?*

—Vedism is known to us through the vast



An 18th-century Indian miniature illustrates a scene from the great national epic, the *Ramayana*, in which the exiled Rama crosses a river in company with his wife Sita and his brother Lakshmana.

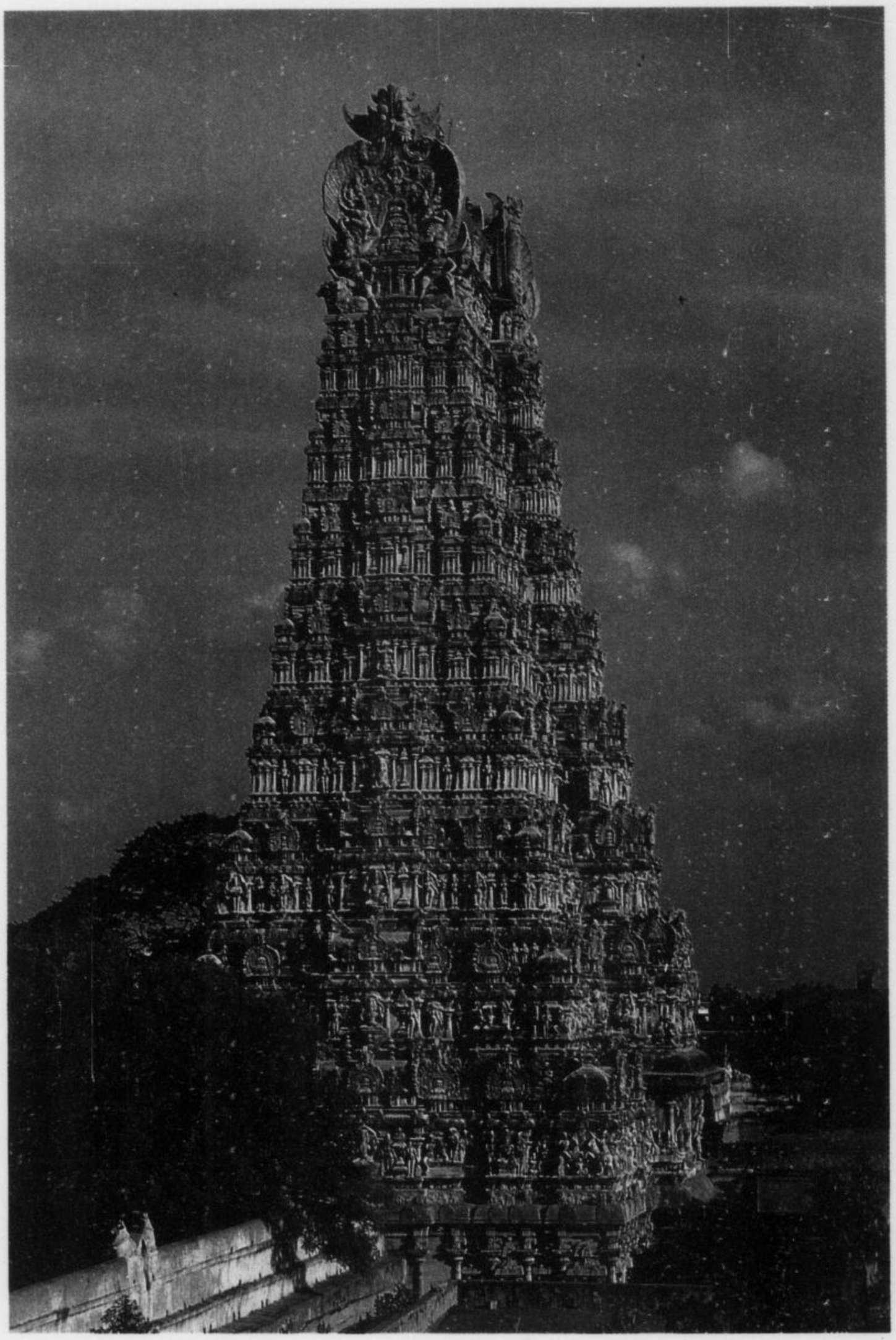
corpus of texts called the *Veda.* These were composed at various dates between 1500 and 500 B.C. There is no similar body of literature for Hinduism proper—certainly not one that is as clearly defined or that carries the same authority. Even so, as the word "epico-Puranic" that is sometimes applied to Hinduism suggests, the two great epics of the *Mahabharata* and the *Ramayana*, along with the vast mass of encyclopaedic writings known as the *Purana*, are in a certain sense the sacred books of Hinduism, containing ideas that all Hindus accept. These epics were composed in the closing centuries of the 1st millennium B.C., the *Purana* about a thousand years later. These dates are approximate.

■ ***Where does the Bhagavad Gita fit in?***
—It's a fragment of the *Mahabharata.*

■ ***Is there any link between the* Purana *and the Vedic hymns?***
—They belong to two very different literary forms, and their content is also different. The *Veda* is often quoted in the *Purana*, and is spoken of with reverence. But the *Purana* (the term means "antiquities") are first and foremost creation myths and genealogies of gods and men, mixed with dissertations on cosmology, ritual, social organization, summaries of various sciences, descriptions of places of pilgrimage and so on. Some of these elements also exist in the Vedic corpus, but the format and the diction, if I may use that word, are quite different. The *Purana* are long-winded, jumbled, loosely expressed. The Vedic hymns, on the other hand, are dense, profound, often hermetic: they are great poetry.

■ ***Could you describe the* Veda *more precisely?***
—As I said, the *Veda* is a corpus of texts. It is our only source of information about India from 1500 to 500 B.C. There are no other written sources, no external evidence, no archaeological remains to speak of. The texts themselves are composite, varying greatly in age, content and form. Yet they are all linked, the latest elements presupposing a knowledge of the earlier ones, since they quote them. But orthodox Hindus today see the *Veda* as homogeneous, in the sense that they regard the whole work as a revealed text. The revelation concerns gods as well as human beings, and although it was not delivered in one piece it does not assume a chronological framework implying a before and after.

■ ***In using the word "revealed" you suggest comparisons with other religions founded on holy scripture.***
—There is a great difference between the *Veda* and revelation in the religions based on the Bible. The *Veda* is not generally viewed as the word of a god addressed to humanity but as a text outside of time that exists of itself and reveals itself by itself. Strictly speaking, the *Veda* has no author. But men of exceptionally powerful vision "saw"—that is the word that



The 17th-century temple of Minakshi, the consort of Shiva, rises above the Indian city of Madurai.

is used—different fragments, different versions of the text, put their vision into words and passed it on to other men. These visionaries are known as *rishi*, a word usually translated as "seer".

Yet even though the revelation has been "seen", the *Veda* is primarily sound-oriented. It is a collection or sequence of sounds formed into meaningful words. The text of the *Veda* is a manifestation of the word; words are oral, made up of the sounds of language, and all their power comes from vibrations of the sound-waves. Furthermore rhythm, as determined by the number of syllables and the arrangement of long and short syllables, plays an important part in the symbolism of the work. A final point: the usual word to designate the *Veda* as revelation is *çruti*, literally "hearing".

What is so extraordinary about the Vedic revelation, then, is that the knowledge it contains (for *veda* means "to know") was "seen", yet it consists of sounds. Nor can one resolve the paradox by imagining that the "seers" viewed a written text they subsequently translated into spoken words, for the very notion of writing is completely foreign to the *Veda*. Even in later times when India had writing, the very idea that the *Veda* could be learned otherwise than by repeating the words of a master was vigorously rejected.

■ ***Does this Word without an author have its own specific intercessor?***

—Only the *rishi*, the seers who transmitted the text to humankind through the medium of sound. But they are not strictly speaking intercessors, for they only put the *Veda* into words, rather than interpreting it. What's more, there is no question of them operating in the other direction by transmitting the thoughts or desires of human beings to the *Veda*. They are simply the mouthpiece of the *Veda*. The *Veda* is a text they discover and that was there before them, not one they have shaped themselves.

■ ***So it is an oral message that over the centuries has been committed to writing and transmitted in written form. How much do we know about the transmission process?***

—We don't know exactly when or how India acquired writing. The oldest inscriptions date from the third century B.C., and their technique is so fine as to indicate a long previous history. But there is no doubt that the corpus of Vedic texts, or at least the oldest part of it, was constituted and transmitted from generation to generation over many centuries without the aid of writing. And I would repeat that even when writing became common in India, even when the *Veda* could be written down, the text was still usually passed on orally from master to pupil. To all intents and purposes this process continued until our own day. Studying the Veda means learning it by heart by repeating it after the master. Highly elaborate techniques are used to memorize such long and difficult texts. But then even scholars for whom reading and writing are everyday activities habitually learn religious and even non-religious texts they consider important by heart, however long these texts may be.

■ ***How would you describe the Vedic corpus itself?***

—Two principal layers can be discerned in the text. The older consists of collections of poems in the form of prayers, or more often hymns, glorifying a god or a group of gods, or the sacrificial act and its various elements, or the people who carry it out. The most important of these collections is the *Rig-Veda*, the "Veda of Laudatory Stanzas", which comprises about a thousand poems. The other important group is the *Atharva-Veda*, part of which consists of magical texts. One of the main themes of the Vedic hymns is a celebration of the power of the word, which means ultimately a celebration of Vedic poetry by the *Veda* itself. The hymns are composed in an archaic form of Sanskrit. The style is often obscure, marked by figures of speech, particularly metaphors, of great power and boldness.

The more recent layer consists of the prose treatises known as the *Brahmana*, which explain what the various sacrificial rites of the Vedic religion are and how they should be understood. They provide liturgical instruction, but also information on the symbolism of the rites and on their links with mythology. Furthermore, since the performance of the rites calls for the recitation, in whole or in part, of Vedic poems, the *Brahmana* explain why specific ritual gestures are associated with specific texts. In this respect, the *Brahmana* can be considered as a commentary on the Vedic poems.

The *Brahmana* themselves have appendices, the *Upanishads*. The *Upanishads* come right at the end of Vedic literature, and Indians like to say that they contain the *Veda*'s deepest meaning. The content of the *Upanishads* consists of speculations whose starting-point is a meditation on ritual. But this meditation ends by going beyond ritualism: rituals are no longer considered in themselves but as symbols of the cosmos and of the organization of the spirit. This "meta-ritualism" lays the foundations for a metaphysical world view.

To sum up, the hymns, the *Brahmana* and the *Upanishads* jointly make up the Vedic revelation.

To make learning and understanding the *Veda* easier, India developed very early on, towards the end of the Vedic period, auxiliary sciences known as the *Vedanga*, literally "members" added to the body of the Veda. These are phonetics, grammar, etymology, astrology, the study of metre, and the analysis and use of ritual. Despite their Vedic origins, some at least of these disciplines came to be studied for their own sake and became non-religious fields of study.

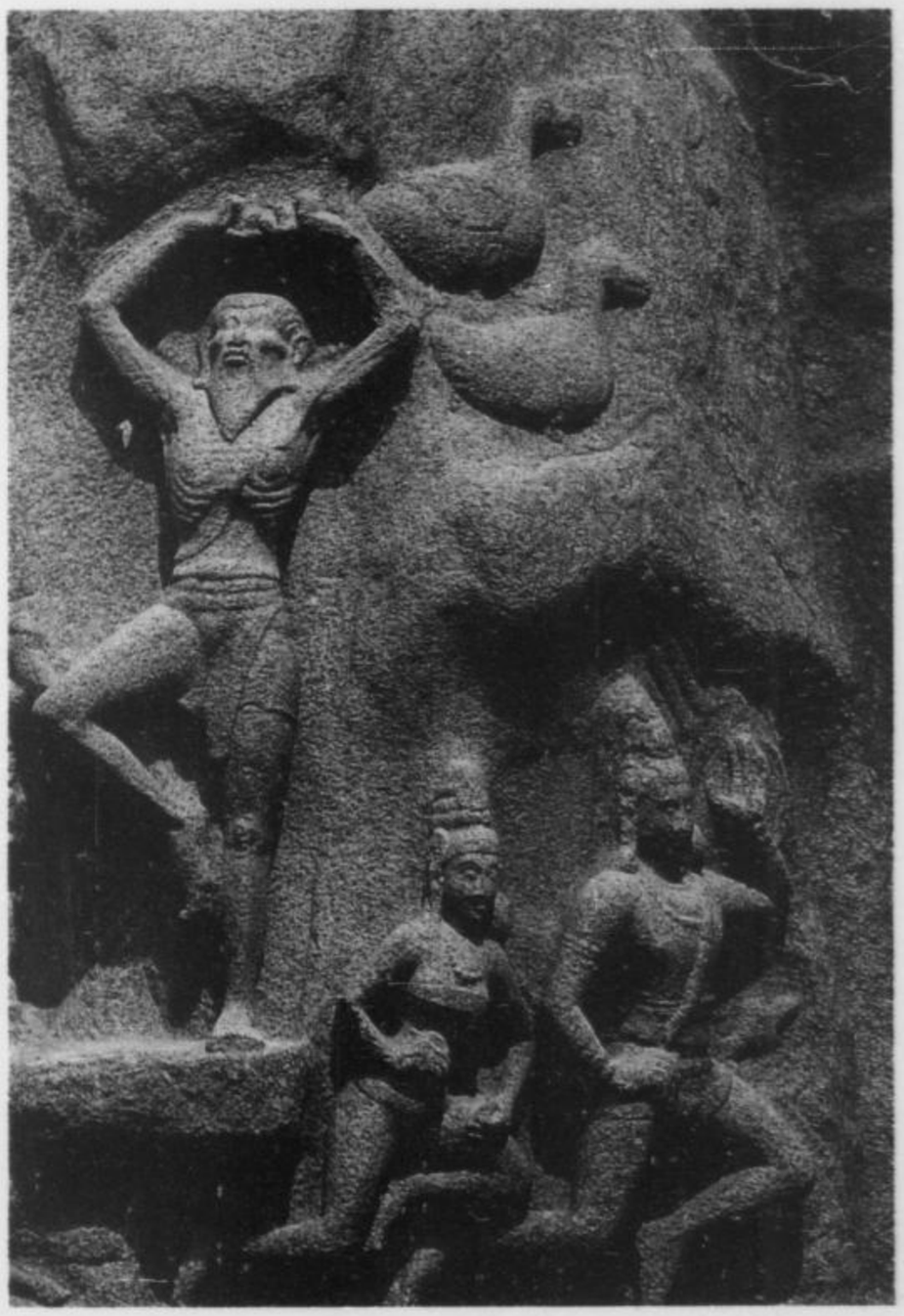
One should add that literal commentaries exist for most of the Vedic texts. These are for the most part quite late, but they are considered authoritative.

■ ***The word* brahman *seems to crystallize certain links, particularly the necessary one between the divine word and human speech.***

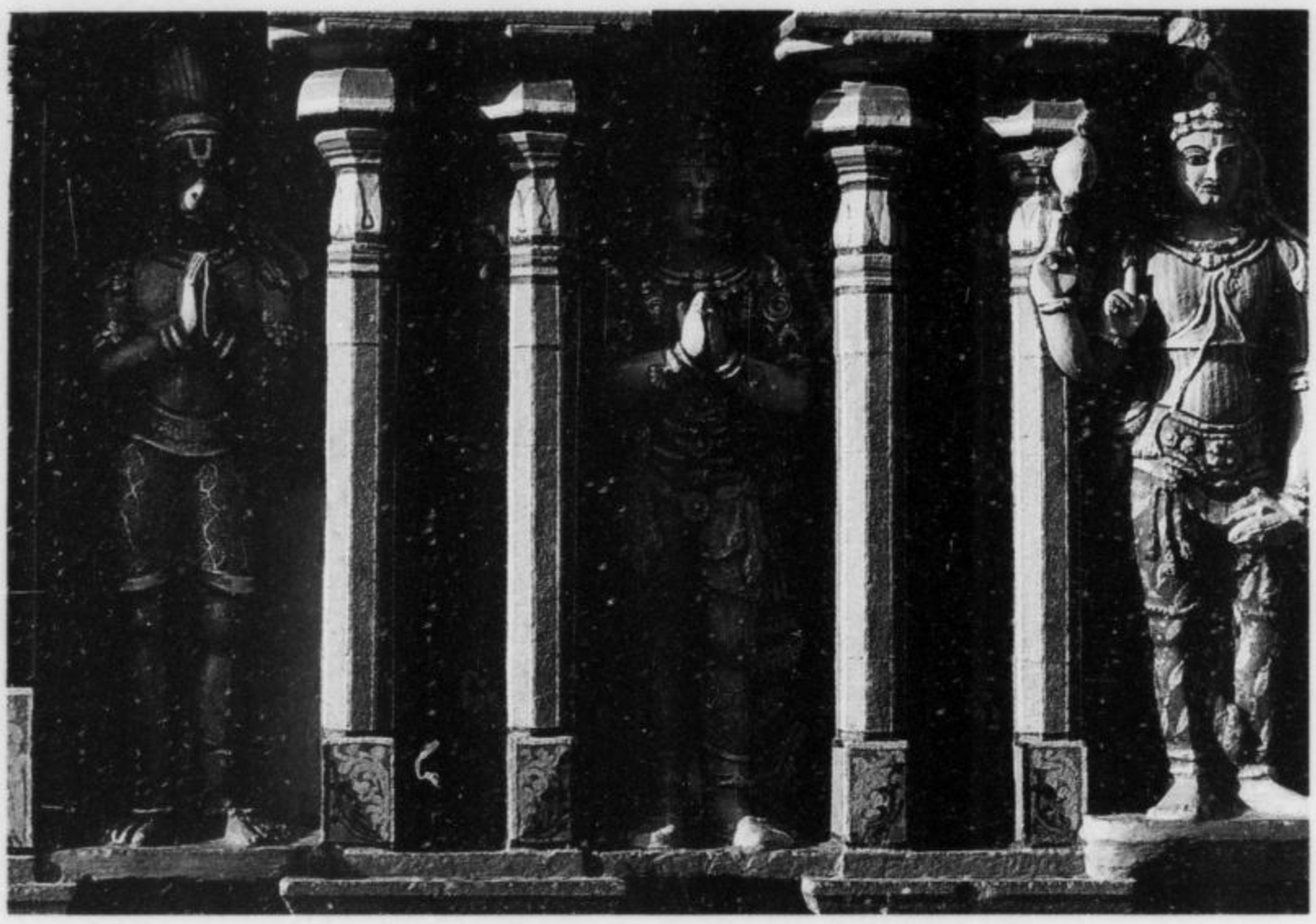
—The word *brahman* is without any doubt the most mysterious in the Sanskrit language. In the speculative tradition that begins with the *Upanishads, brahman* links up with *atman.* The *brahman*, the Absolute of the universe, corresponds to the *atman*, which is the Self, the Absolute as revealed in the reflexivity of the individual soul.

The term *brahman* lies at the root of a whole complex of derivations that need some explanation. First and foremost we have the word *brahman* itself, which is neuter in gender. Its principal meaning is "essential content of the *Veda*". Because the Vedic poems contain many statements in the form of riddles, *brahman* also comes to have the secondary meaning of "riddle" or "enigma".

The first derivation is *brahman*, gender masculine, which designates men who are particularly well-versed in knowledge and use of the neuter *brahman* in its first sense. In



An ascetic, as depicted in the huge 7th-century sculptured rock relief at Mamallapuram (Mahabalipuram) depicting "The Descent of the Ganges from the Himalayas".



Characters from the *Ramayana* adorn the Ranganatha temple at Srirangam, in Tamil Nadu state, southeastern India. The temple dates from the 10th to the 16th century.

Vedic ritual the *brahman* is the priest whose job is to check that exactly the right formulas are employed. As the "doctor of the sacrifice" he says next to nothing but is, as it were, the incarnation of the Vedic text on the sacrificial ground. In post-Vedic Hinduism, Brahman in its masculine form can also be a proper name, for Brahman or Brahma is one of the great gods who, with Vishnu and Shiva, makes up the supreme triad, the triple figuration known as *Trimurti*.

Then there's the word *Brahmana*, which means "that which has reference to *brahman*" and designates the sacrificial treatises I spoke of earlier. *Brahmana* has another meaning in Sanskrit, and that is what we think of when we use the word "brahmin", which is to say a man born into the highest of the four "classes" of the Indian social hierarchy, the priestly one. Brahmanism is the religion that considers the brahmins to be the repositories of Vedic knowledge, and that they alone are entitled to officiate during sacrifices.

■ ***Can one say that the* Veda *created the world?***

—Yes, certainly. The role of the Vedic texts in the Creation is one of the themes of the *Veda*. It is both a poetic motif and a principle of the Vedic religion.

■ ***How does sacrifice fit into what might be called the geography of the sacred?***

—The sacrificial rite is one element among others in the Vedic religion. Not all Vedic ritual is sacrifice, just as not all the religion is ritual. It is true, though, that sacrifice is the main subject of the Vedic texts, and their expositions of mythology and the creation of the universe, their speculations on the correspondences between the macrocosm and the microcosm and so on, are presented in the context of sacrificial instructions. They also tend to analyse such other rites as prayer, funerals and marriages as though they too were forms of sacrifice, organized in the same way and with the same division of roles between the participants.

Furthermore, as Louis Renou has pointed out, one can see the idea developing that the Vedic compilations are nothing more than collections of mantras, forms of words to recite during ceremonies. The gestures and objects involved in rites become sacred and effective insofar as they are "sacralized" by the recitation of appropriate mantras.

It should be said that the clearest and most vigorous creation stories present genesis itself as a sacrifice, with the different elements of the cosmos and of society coming from the dismemberment of a primordial victim, and also that the core of Vedic mythology hinges on the efforts made by the gods to take possession of the sacrificial procedures and instruments or to put them to their own exclusive use.

But another characteristic of Vedic civilization is that it produced thinkers, true intellectuals in my view, who reflected on the formal structure of the sacrifice, on the way in which the various parts are linked and on how all the acts of which it consists are joined and separated. And since you mentioned "geography", I would add that sacrifices take place in the open, in a space equipped with fire-altars and poles. Vedic ritualists devised a whole system of geometry to make sure that this equipment is set up in conformity with the canons of shape and size. Yet the sites themselves are considered "abstract", in the sense that we know of none that was marked out to serve exclusively as the stage for any particular rite.

■ ***To whom are the sacrifices offered up?***

—To the gods or, using different procedures, to ancestors. There is a whole mythology of sacrifice, which can itself be seen as a divine being, just as the word can. Various gods of the Vedic pantheon have a double aspect, a twofold reality. For instance fire—*Agni*—is both a god to whom prayers are addressed and the flame lit in the altars to receive offerings. Soma is a god, but also a plant whose juice is considered the drink of immortality and is therefore itself offered up to the immortal ones.

Vedic speculation, particularly in the *Brahmana*, tends to suggest that the gods depend on the sacrifices made to them and in a sense are even raised up by these sacrifices. The right order of the world, prosperity in our present existence and salvation in the after-life can all be achieved by correct execution of rites, much more than by any kind of divine acquiescence or grace.

■ ***If sacrifice, in conjunction with the word, helped to create the world and even the gods themselves, is it possible to say that there are established correspondences between the macrocosm and the microcosm, the divine and human worlds?***

—Yes, such correspondences exist, but it is up to humans to discover them, to become aware of them, to formulate them—and in so doing, to confirm them. Solving the Vedic riddles I

CONTINUED PAGE 49

TO OUR READERS

OPERATION SOLIDARITY
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Three months ago we launched "Operation Solidarity", inviting readers to offer a subscription to the *Courier* as a gift to a school, library or university in a country of the South. The response has been so encouraging that after only a few short weeks we can report that the Operation is turning out to be a great success. More than a hundred subscriptions have already gone out to recipients in Asia, Africa and eastern Europe, and this is hopefully only a start, the first step on a road leading to close and lasting ties across geographical and political frontiers. The many letters we have received testify that solidarity is an ideal that seeks an intellectual outlet as well as other more tangible forms of expression.

Thank you for your generosity.

PLEASE KEEP IT UP!

Many readers have written to offer suggestions and to tell us about their own ideas and projects

The Amiens Cultural Centre has invited the UNESCO Courier to present Operation Solidarity at the Cultural and Community Fair it is organizing on 15 and 16 May.

3 Place Louis Dewailly, 80037 Amiens, France

Philippe Guirlet would like to set up a kind of electronic information exchange through which scientific and technological know-how, educational materials and ideas could be swapped.

99 rue Louis Bectard, 77360 Vaires sur Marne, France

Margaret Allen writes from Kansas to suggest that journalists in developed nations could help their young colleagues in countries of the South by providing them with information about equipment and resources.

Margaret Allen, 3006A Tulane Place, Hutchinson, KS 67502, USA

WRITE TO US

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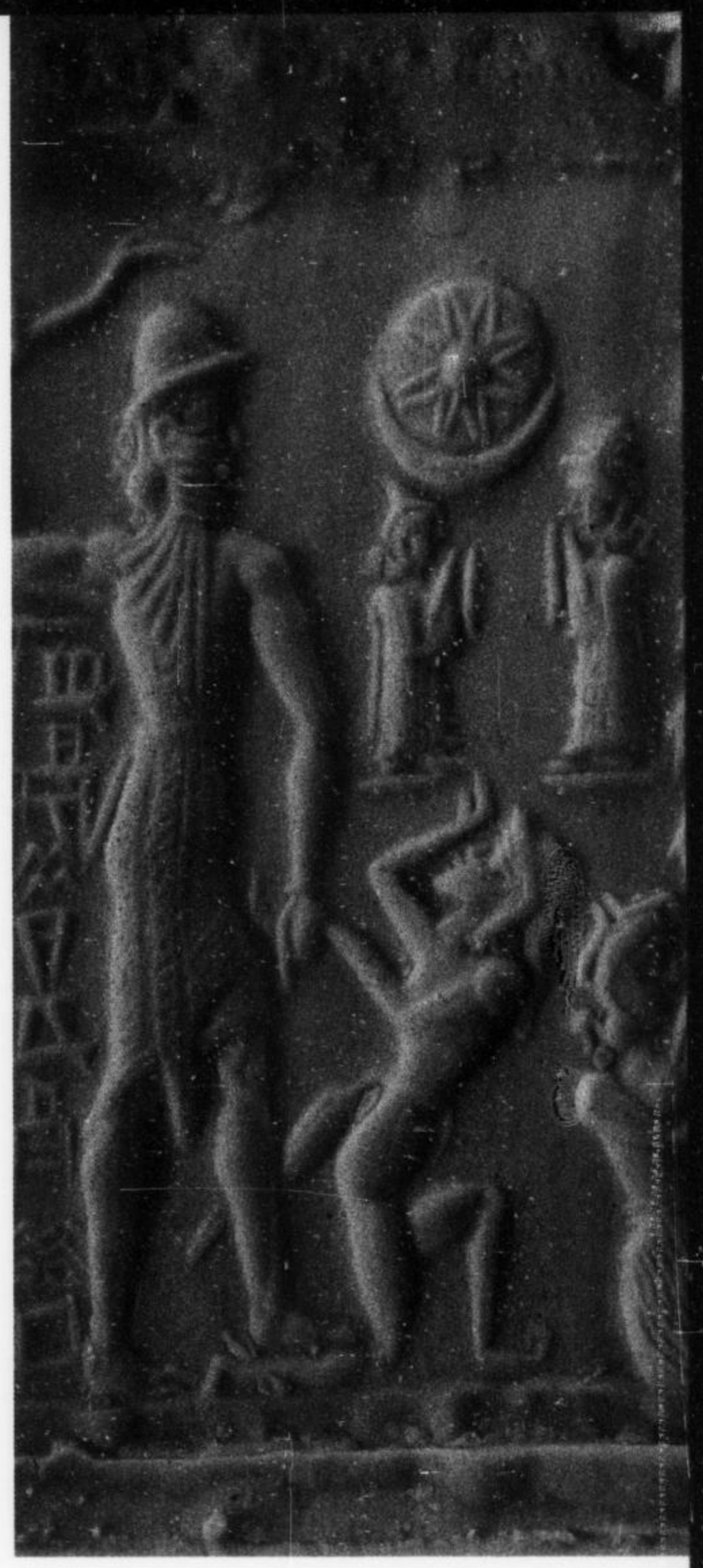
Once upon a time in Sumer...

by Arie S. Issar

For most of human history, water was the stuff of myth. Only in the 17th century did an approach based on observation and experiment lead to the birth of modern hydrology



EVER since very ancient times, human beings have tried to explain the wonders of water, for which they at first attributed responsibility to deities whose deeds were sung in hymns and transmitted as myths and legends.

The earliest of these stories to come down to us were written down in Sumer, Mesopotamia, about 4,500 years ago. They tell of a universe composed only of water, from which arose a cosmic mountain that contained both heaven and earth. The Sumerians believed that at the creation of the world there was a fight between the benevolent gods and Kur, the god of the nether world, who controlled the primeval waters. Kur was involved in a foul deed committed against Ereshkigal, the sky goddess. Ereshkigal was helped by Enki, the water god, who set out in a boat to attack Kur. This evil god fought back by sending the primeval waters to sink the boat, but Enki, the god of good water, triumphed.

The Babylonians, who adopted many Sumerian traditions, chanted during their New Year festivities the epic tale of the victory of the benevolent god Marduk over Tiamat, the goddess of the abyss. The tale began as follows: "When in the height heaven was not named, And the Earth beneath did not yet bear a name, And the primeval Apsu who begat them, And chaos, Tiamat, the mother of them both. Their waters were mingled together." (*Enuma Elish*, The Seven Tablets of Creation, Tablet One).

In the Old Testament, the existence of a primeval ocean is taken for granted. The story of creation begins when "darkness was upon the face of the deep. And the spirit of god moved upon the face of the waters" (*Genesis* 1: 2). Interestingly, the Hebrew word for "the deep" is Tehom, which brings to mind the Babylonian Tiamat. After being defeated by Marduk, this entity representing the abyss of primeval waters and chaos was divided into two parts to form the bodies of atmospheric water and underground water:

"Then the lord rested gazing upon her [Tiamat's] dead body while he divided the flesh of the body and devised a cunning plan. He split her up like a flat fish into two halves. One half of her he stablished as a covering for heaven. He fixed a bolt; he stationed watchmen and bade them not to let her waters come forth. . . . And over against the Deep he set the dwelling of

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Nudinmud[1]". (*Enuma Elish*, Tablet IV, 135-142).

This story is reminiscent of the dividing of the waters by the Creator as narrated in the Bible: "And God made the firmament, and divided the waters which were under the firmament from the waters which were above the firmament: and it was so. And God called the firmament Heaven." (*Genesis* 1: 6-7).

Another reference to an ancient abyss apparently connected to the primeval waters is found in the Canaanite myths deciphered from the clay tablets found when the ancient city of Ugarit, on the eastern shore of the Mediterranean, was excavated. In these myths El, the primeval deity, lives at the sources of rivers in the midst of the outlet of two deeps called Teomotaim.

Thus the Babylonian Tiamat, the Canaanite Teomotaim and the Hebrew Tehom may all be manifestations of the same idea of a state of chaos, of an endless abyss of primeval water, a state where life cannot exist and thrive. These elements are also found in the *Rig-Veda,* an ancient Hindu text in which the slaying of the cruel dragon Vrtra by the valiant Indra involves piercing the bellies of the mountains and letting the water flow out.

In an impression taken from a Babylonian cylinder dating from the 2nd millennium B.C., Enki, the god of fresh water, is shown amidst small goddesses and streams of water teeming with fish.

1. The father of Marduk and the creator of humanity.

THE PRIMEVAL ABYSS

There is good reason to believe that these ideas originated in prehistoric times, were brought to Mesopotamia, transmitted to the Harappa pre-Aryan civilization of northern India, and later absorbed by the Aryan conquerors who settled in this region during the second millennium B.C. They may also have spread from Mesopotamia to Egypt during proto-historical times, brought by conquerors from abroad, probably from Mesopotamia. The ancient Egyptians believed in the emergence of a primeval mound from an abyss of primeval water, at the site of the temple of Atum-Ra at Heliopolis. The primeval waters stretched endlessly in all directions. The rising of the creator, the god Atum, from this water was also the manifestation of the creation of order and life. As long as he was immersed in the primeval waters, all was chaos.

Ancient Egyptian texts found in the pyramids describe the Creator, who is the outflow of the Primeval Flood, and who emerged from the waters, as a serpent with many coils. In the cosmic myth of Hinduism, the god Vishnu, the source of the world and all things, is depicted as sleeping, before the Creation, in the primeval ocean, on the

thousand-headed serpent Sesa. In his sleep a lotus grows from his navel, and in the lotus is born the demiurge Brahma, who created the world.

The same basic ideas are found in the pre-Hellenic mythologies of ancient Greece. Although in these myths creation is attributed to a woman's touch, the motifs of a primeval ocean and a snake recur: Euronome, the goddess of all things, rises naked from chaos and divides the sea from the sky, dancing lonely upon the waves. She catches hold of the north wind, rubs it between her hands and thus creates the great serpent Ophion. In the Homeric myths, all gods and all living creatures originated in the stream of Oceanus which girdles the world.

Sumer was located in the lowlands of Mesopotamia, near where the waters of the Tigris and the Euphrates flow into the sea. In a dry year, when river levels are low, seawater encroaches into the river inlets and the subsurface. Today we know how to calculate the decrease in the flow of a river as a function of the quantity of precipitation in its catchment area, thereby making it possible to forecast the rate of recession of the fresh water and the penetration of the sea water. The Sumerians, however, did not connect the encroachment of the sea with the lowering of the water level in their rivers. They had a conceptual model which claimed just the opposite, namely that the water of the river receded because Kur, the great god of the primeval waters (symbolizing the saline water of the sea as well as subsurface water) became furious with Niuntra, the god of the south wind. According to the Sumerian poem, as Kur rises the Tigris does not rise, famine rages, the water in the small rivers does not rise, the fields are not irrigated, and nothing grows but weeds. Niuntra solves the problem by building dikes to protect the rivers against the encroaching sea water. This stops the flow of the fresh water into the sea and raises its level so that the fields can be irrigated.

Thus a natural disaster and a feat of clever engineering are reported in the form of a conceptual model which seemed logical to the ancients. The king or the irrigation engineer who devised and ordered the construction of the dikes understood that the recession of the Tigris and the penetration of the sea were interconnected. He might not have understood that the low level of the Tigris was due to a dry spell caused by low rainfall on the Zagros mountains and that the encroachment of the sea could have been enhanced by a global rise in the sea level due to a climatic change which caused the glaciers at the poles to melt. What he saw and understood was the change in the balance between the water of the Tigris and the water of the sea, and he found a way of coping with it. This however was not sufficient; he also had to put forward a theory to explain what happened, and the theory that came to his mind entailed a fight between gods.

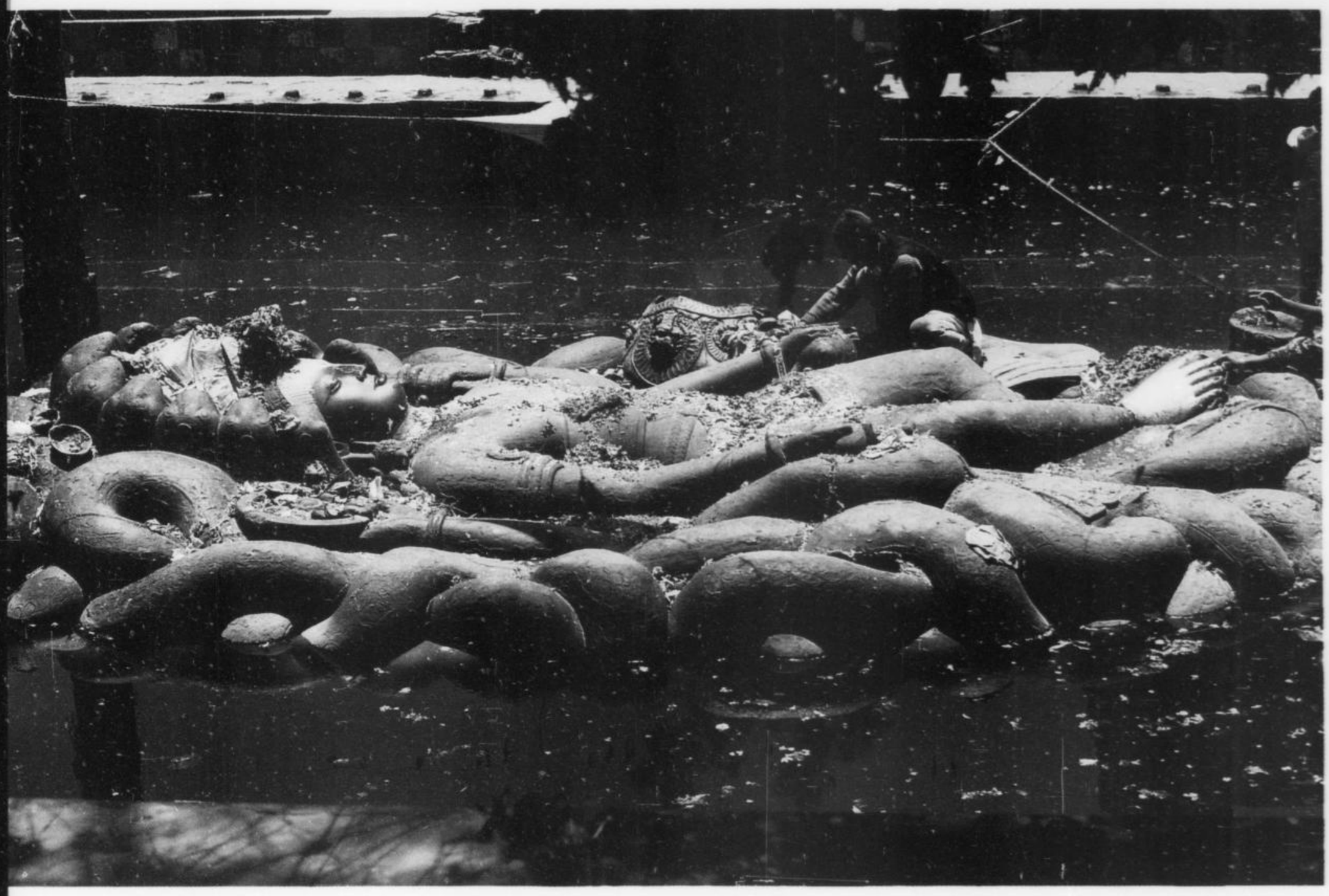
This diagram of a hydraulic machine is an illustration from Athanasius Kircher's *Mundus Subterraneus*, a 17th-century treatise on geology.

THE DELUGE—MYTH AND REALITY

Another story found in many ancient mythologies is that of the Deluge. The oldest known version is Sumerian. Adopted by the Babylonians and Assyrians and repeated in the Bible, it is explained in terms of an ethical world-view. In the mythologies of the people of Mesopotamia, the Deluge occurs because the gods fight among themselves, while in the Jewish version it is God's punishment for the wickedness of the people.

The conceptual model suggested by the present author is that a flood did indeed affect the Mesopotamian plain at the dawn of history, caused by a global climatic change that caused the glaciers to expand and rainstorms to sweep over the Mediterranean as far as the Levant. This caused flooding in the lowlands. One reason for this suggestion, in addition to the palaeoclimatic evidence, is the fact that all the ancient stories, although written in a land of rivers, give the reason for the floods as rain and not river overflow. This indicates that the deluge was a climatic anomaly.

As we have seen, the conceptual model of the ancient Greeks also involved a primeval abyss of water. This conception might have been formed in prehistoric times, before the Greeks reached their peninsula. Once settled there, they became concerned with the origin of springs. Greece is a Mediterranean country where most rain falls in winter. Summers are long, hot and mostly dry, and during them the water supply depends on the flow of the springs issuing in many cases from



A massive sculpture at Buddhanilkanta, near Kathmandu (Nepal) shows the god Vishnu reclining on the coils of the serpent of eternity.

limestone caverns. Greek mythology regarded springs as the place of residence of Pan, a god who enjoyed playing a flute made from reeds growing at the waterside.

In Greece in the sixth and fifth centuries B.C., there was a school of scientists and philosophers known as the pre-Socratics, who combined observation and logic to explain natural phenomena. It can be claimed that the pre-Socratics were the first thinkers to use non-religious conceptual models and theories in an attempt to understand nature. One theory to explain the phenomena of springs was suggested by the pre-Socratic philosopher Anaxagoras of Clazomenae (500-428 B.C.). His writings have not survived, but fortunately Aristotle, who lived about a hundred years later, refutes him after citing him in his book *Meteorologica.*

Anaxagoras put forward the theory, advanced for its time, that all groundwater originates from rain, which is raised by the Sun (evaporation), then falls on the Earth and collects beneath it in great reservoirs. Rivers, which are fed by springs, are fuller in winter when the subterranean reservoirs are full, and diminish in summer when these reservoirs empty. Some rivers even dry up altogether when their sources of supply empty before fresh rains come. Anaxagoras also maintained that no water is generated during its flow through the hydrological cycle. This is the first statement of the principle of conservation of matter.

Aristotle did not agree with this theory. He claimed that the volume of water is much greater than the volume of the Earth, and suggested another conceptual model in which he maintained that water is formed continuously in the Earth from air, which he considered to be a sort of aqueous vapour. He also seems to have believed that juvenile water is replenished from the depths of the Earth. He suggested that high mountains cool the vapours that rise from the lowlands and condense them into water.

In this conceptual model Aristotle tried to weld meteorological and hydrological observations into a single rational theory. It seemed to him that the volume of water flowing in springs and rivers is much greater than the volume of the Earth in which it had to be stored. Aristotle explained this discrepancy by the idea of the continuous generation of water. This was the basic flaw of his theory.

RECONCILING ARISTOTLE WITH CHRISTIAN TEACHING

The Romans, who adopted the Hellenistic philosophical and scientific paradigms, were practical people. Their engineers preferred perennial springs to rivers as a source of safe and continuous water supplies for their cities. They liked these springs to be on a higher altitude than their cities so that there was enough pressure for the water to flow along beautifully constructed aqueducts and emerge as fountains in the midst of the cities. When perennial springs were not available, in the vicinity of cities in the more arid parts of their empire, they dug wells to reach groundwater. They probably learned this technique from local people who knew from proto-historical times how to locate and use groundwater.

Aristotle's erroneous assumption about the volumes of water and Earth, and the theory of the

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perpetual generation of water which he developed to answer it, dominated the scientific thinking of civilization for more than 1,500 years. Aristotelian views were adopted by the Christian church and were taught in its schools to the monks and priests who formed the literate class. However, they were not accepted at their face value. They had to conform with the Holy Scriptures, and much "scientific" research during the Middle Ages and later was devoted to reconciling Aristotelian views with the Bible and other convictions of the church. The Scriptures were for the monks a basic truth, like an observation of nature that could not be doubted. Indeed, Aristotelian writings and the Bible had greater authority than any observation and thus provided the postulates upon which the world-view had to be based.

THE DEVELOPMENT OF SCIENTIFIC HYDROLOGY

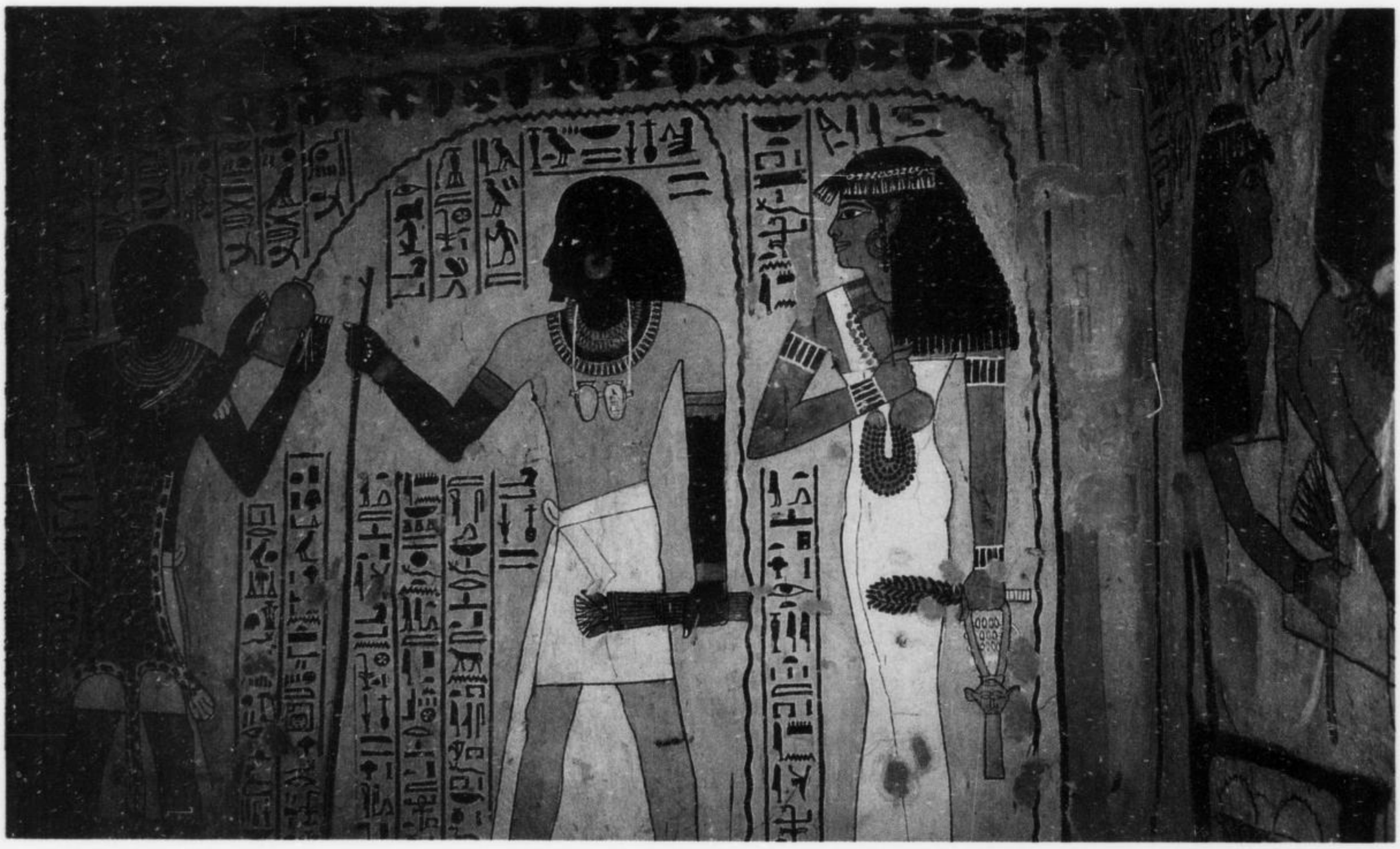
In the seventeenth century, new ideas on the need to study nature by observation became widely current. Adherents of the classical paradigms of the church tried to find a middle way between the Holy Scriptures and their own observations. One solution was the theory advanced by the German Jesuit Athanasius Kircher, who in his book *Mundus Subterraneus* (1665-1668) suggested that there are holes in the seabed which communicate with caverns in the mountains and that as a result of various processes the water is made to flow upwards, thus fulfilling what is stated in the Bible. Many other scholarly acrobatics were performed by pious people in order to reconcile the Holy Scriptures, Aristotle, and observable hydrological phenomena.

An unbiased understanding of what really happens in nature came when people freed themselves from the obligation to regard the ancient writings as truths to be trusted more than observations. Once this happened, new conceptual models were created by such unconventional thinkers as Leonardo da Vinci (1452-1519) and Bernard Palissy (1510-1589), who hypothesized that spring water consists of rainwater percolating through porous and fractured rocks.

The proof of these conceptual models came when a quantitative approach was applied. This was done first by Pierre Perrault, whose book *De l'Origine des Fontaines* (1674) presented a quantitative hydrological balance of the drainage basin of the River Seine. This showed that all the water that was drained by the river amounted only to about one sixth of the total rainfall on its catchment basin. This was followed a few years later by another set of measurements and calculations by the physicist Edme Mariotte, who modified the figure to about one-eighth. Other quantitative investigations which followed during the eighteenth century established the theory of the hydrological cycle as it is found in modern textbooks.

Later, more precise calculations were made. The engineer Henri Darcy calculated the flow of water through a porous medium and thus formulated what is known as Darcy's Law, which states that the volume of water flowing through a certain section of porous rock is equal to the permeability of the rock multiplied by the gradient of the water table. This law was further developed for application to various conditions by hydrologists during the nineteenth and twentieth centuries.

With the coming of the computer era, some hydrologists came to think that in the future only very few field investigations would be needed to supply basic data, and that all the rest of the work would be done by computer. This approach is reminiscent of the Greek belief at the dawn of the classical era of philosophy, that logical reasoning based on just a few observations would be sufficient to reveal the mysteries of nature. ■



A scene from the lavishly decorated tomb of Sennefer, known as the "tomb of the vines", at Thebes, Egypt (15th century B.C.).

Underground water is an important, little-known and fragile resource

A hidden asset

by Jean Margat

UNDERGROUND water was for centuries the great unknown of the water cycle. Despite the intuitive insights of a small number of geniuses, from the Greek Anaxagoras and the Roman Vitruvius to Leonardo da Vinci, it long remained the stuff of myth and imagination. Until the time of Descartes, people thought it came from the sea and somehow made its way up to mountain springs, desalinating itself en route. Its place in the circulation of the Earth's water was not understood until the seventeenth century. And we have only recently learned how to measure its volume and flow.

REGULATING THE FLOW OF STREAMS AND RIVERS

Virtually all terrestrial freshwater resources in liquid form are underground. The 10 million billion cubic metres of underground water represent more than a hundred times the amount contained in all the world's lakes and rivers at any given time. And even though it is less than the 28 million billion cubic metres contained in the Earth's ice masses, subterranean water is more evenly distributed on every continent.

Above, digging a well in Burkina Faso.

Underground water is not stagnant. Although it flows very slowly, its mass in motion makes an appreciable contribution to the general circulation of water. Almost a third of the flow of the Earth's running water circulates underground for short or long distances. The global volume is of the order of 12 thousand billion cubic metres annually.

Subterranean water is linked to surface water through countless springs and other forms of discharge. Without its unseen flow, which is widespread and regular even if rarely observed except by speleologists, there would be neither springs nor permanent rivers. The underground reserves are the great regulators of surface streamflow.

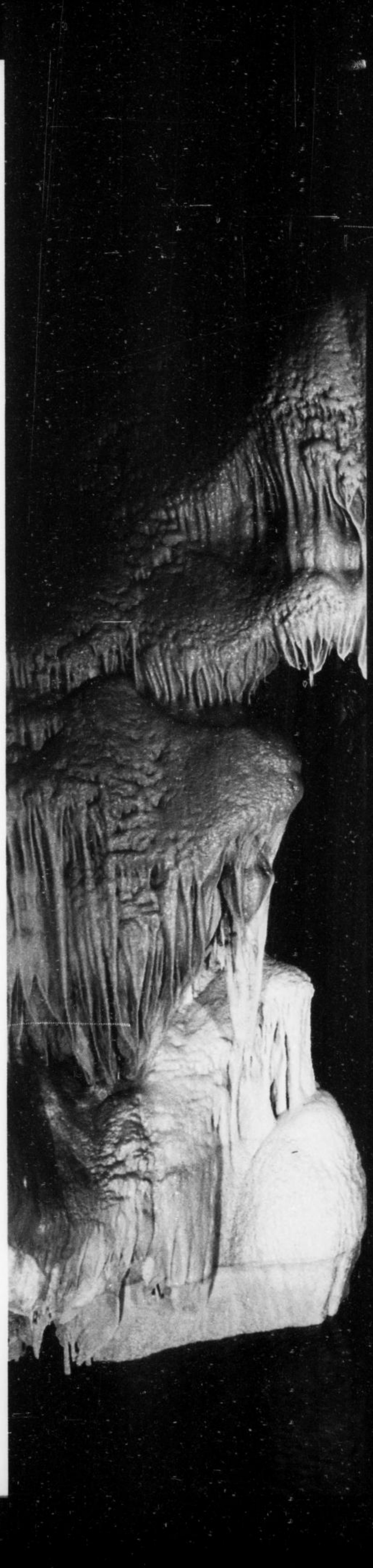
Underground water is distributed in as organized a fashion as surface water, in aquifers that vary both in size and in the complexity of their structures. Sometimes these serve as conduits, sometimes essentially as reservoirs. Every continent possesses major aquifers whose size rivals that of the great river basins, containing billions of cubic metres of fresh water, sometimes as much as one or two thousand metres down.

In spite of progress in the knowledge and skills of the hydrogeologists who study and control it, underground water still means little to the public at large, and even to many engineers and administrators responsible for the management of water resources. The air of mystery surrounding it has encouraged the survival of water-divining, the belief in which is still deeply implanted in many cultures. Underground water is rarely thought of as a communal resource, like rivers, and its legal status is accordingly often different from that of surface waters, whether standing or flowing, which generally fall into the public domain. Property rights to underground water resources are generally linked to ownership of the land above them, and laws pertaining to water usually take little account of the continuity of ground and surface water. The degree to which human activities affect subterranean reserves is either underestimated or ignored.

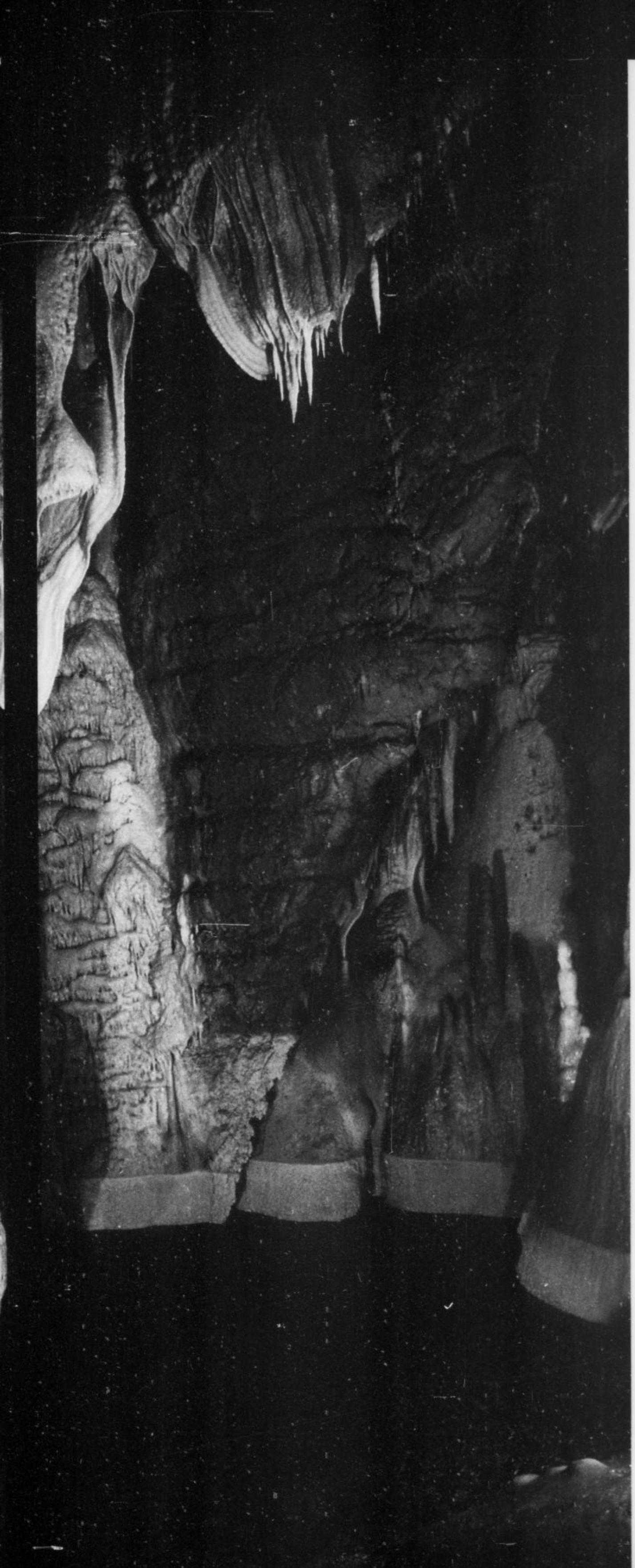
DRAWING ON THE RESERVES

Yet underground water has been used and exploited by humankind for thousands of years. Through the ages, in every part of the world, people have devised different ways of tapping it, using energy sources as diverse as animal labour, wind and solar power and the hydraulic techniques employed in artesian wells.

Examples of the exploitation of underground water resources include Iran's famous *qanats*, galleries hollowed out over the course of the centuries that, laid end to end, would stretch for 400,000 kilometres, the distance from the Earth to the Moon; the 600,000 wells that irrigate the Ho Pei plain in China; the 5,000 wells of Aus-



The Aven du Grelot, a natural well in a limestone region of southern France.



tralia's Great Artesian Basin, which produced 6 billion cubic metres of water in 1980; and the 150 billion cubic metres of water pumped each year in India (a world record). Between 1940 and 1980 500 billion cubic metres were drawn from the Ogallala aquifer to irrigate the High Plains of the American Midwest, where 170,000 wells are currently in use. Thousands of modern wells provide water for the villages of the African Sahel. Two billion cubic metres will be extracted annually from the fossil-water reserves of the Libyan desert to feed the "Great Artificial River".

Underground water has many advantages as a source of supply. It can be easily tapped over wide areas using installations that require small-scale investment rather than the heavy outlay needed, for example, to build dams to control surface water. It is a permanent resource that is relatively insensitive to climatic factors such as drought. In addition, the quality of the water is generally better and more consistent than that of surface water, making it suitable for human consumption.

Around the world today, about 60 per cent of drinking water, 15 per cent of household supplies and 20 per cent of irrigation resources come from beneath the ground. In most of the world's arid lands, subterranean reserves constitute the principal water supply source. In addition, they constitute at least 20 per cent, and often more than 30 per cent, of all the water used in most industrialized countries. About 600-700 billion tonnes are now tapped annually—a greater tonnage than for any other mined mineral.

THE RISKS OF OVER-EXPLOITATION

There is a big gap between what people know about underground water and the use they make of it, and this accounts for much that is wrong with the way it is exploited.

It is an often-undervalued resource that could be more efficiently used during periods of drought. On the other hand, it is sometimes used to excess, and such overexploitation can be harmful in many ways. It is important to realize that underground and surface water resources are not independent of one another, for groundwater helps regulate surface streamflow—a role that could be amplified by using it, for example, to artificially refill storage basins that are in danger of silting up. Considerable though they are, however, freshwater reserves are not renewable within a human lifespan, and so can only be exploited for a limited time. Their use does not allow for sustainable development.

The massive deposits of fossil water that exist in several arid regions are vital resources, even if only some of the water can be extracted, since by the rules that govern any kind of mining operation the intensity of production must control its

duration. In many countries these resources have been exploited since the nineteenth century and have already produced billions of cubic metres of water—35 billion in Australia over 90 years, about 15 billion in the Algerian and Tunisian Sahara in 30 years, 200 billion in Arizona in 60 years, the same figure in 40 years in the American Midwest—provoking sizeable falls in the water table, sometimes of 100 metres or more. Similar, more recent but fast-growing developments now provide the bulk of several Arab countries' needs, providing 75 per cent of Saudi Arabia's water supply and 85 per cent of that of the Libyan Arab Jamahiriya.

But there is a time limit to the mining of underground water: it can only go on for a few decades, a century at most. It therefore becomes necessary either to look for alternative sources for when the water runs out, or else to plan for the transformation of the activities that depend upon it.

Finally, most aquifers are exploited by many different parties for different and sometimes incompatible purposes. And like many river basins, they frequently extend across several regions or even countries. If conflicts are to be forestalled, there must be co-operation between the communities and nations concerned.

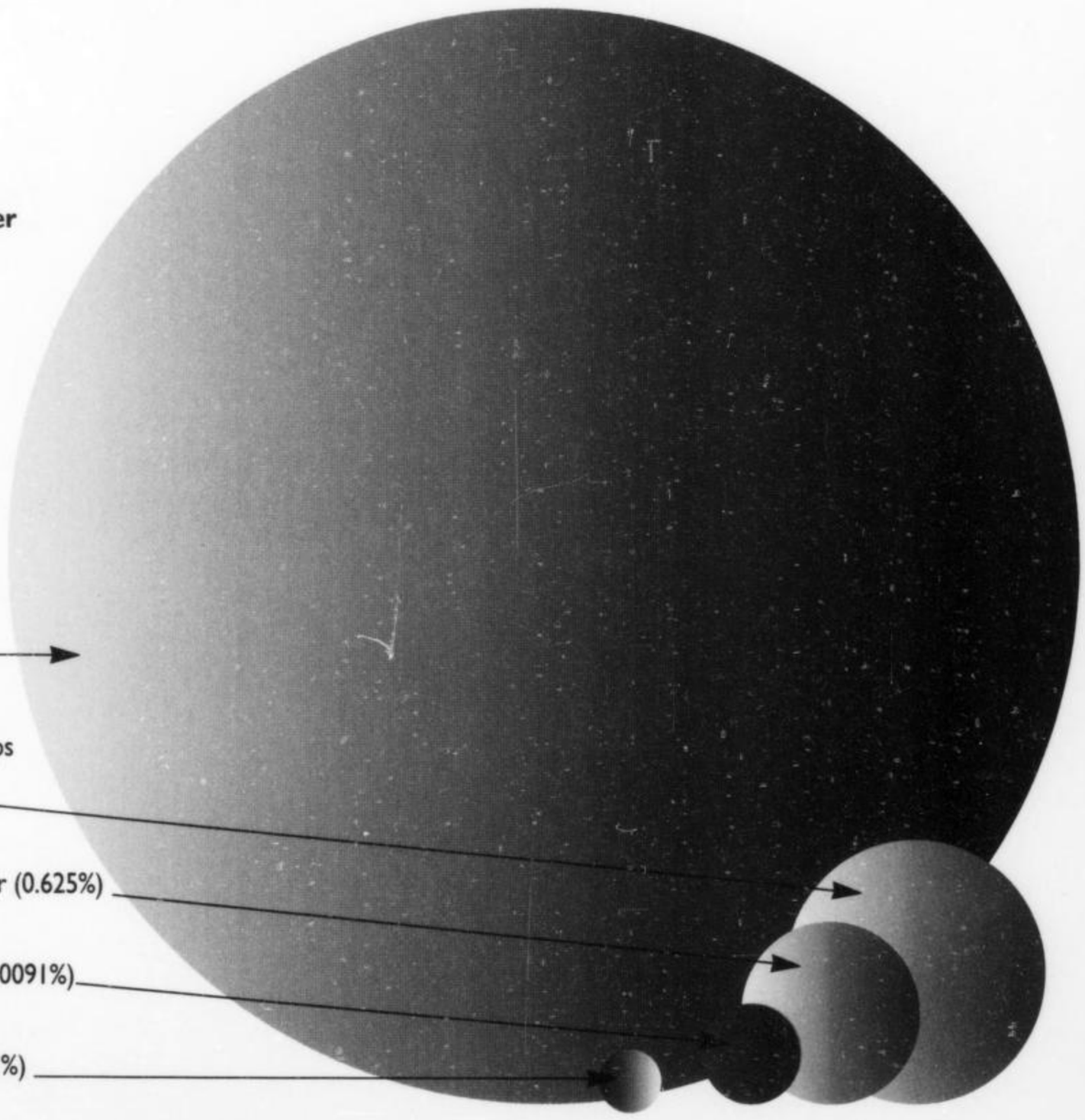
THE POLLUTION TIME-BOMB

The pollution of underground water reserves is even more pernicious than that of surface water, in that it is less immediately apparent and is often diffuse and cumulative. It also lasts much longer. Even local sources of contamination can make their effects felt over great distances and considerable periods of time—sometimes several generations—because the affected water is stored in the soil and is only renewed very gradually.

The principal threat to groundwater comes from harmful substances introduced into the natural environment. This may happen deliberately—through excessive use of fertilizers and pesticides in agriculture, or sometimes even through the dumping of dirty or waste water in cesspools—or unintentionally, by rainwater leaching materials from badly-sealed urban or industrial landfills, for example, or as a result of leaking sewers or reservoirs or following spillage of dangerous products such as hydrocarbons during transport. These forms of pollution, which stem ultimately from negligence or ignorance, have repercussions on the quality of springs and river tributaries. They pose a threat to surface-water resources and aquatic ecosystems.

From both an economic and an environmental point of view, prevention is by far the best way to fight pollution and preserve the quality of underground water. Attitudes will have to change and efforts will have to be made not only by water consumers but—perhaps to an even greater extent—by all land-users, whether public or private, who must be made more aware of the consequences of their acts. ■

The Earth's water



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Escalating consumption is threatening to outpace water supply

Running dry

by Sandra Postel

FOR decades, water has been wasted, mismanaged and overused—and the consequences are beginning to hit home.

Water scarcity typically conjures up visions of drought, the temporary dry spells that nature inflicts from time to time. But while droughts capture headlines and grab our attention, the far greater threat posed by our escalating water consumption goes largely unnoticed.

Signs of water stress abound. Water tables are falling, lakes are shrinking and wetlands are disappearing. Despite the disastrous experience of the years 1955 to 1985, engineers propose "solving" water problems by building ever more mammoth dams and river diversion schemes, with exorbitant price tags and damaging environmental effects. Around Beijing, New Delhi, Phoenix and other water-short cities, competition is brewing between city-dwellers and farmers who lay claim to the same limited supply. In the Middle East, water scarcity stirs up disputes and tensions that threaten to spill over into armed conflict.

In each major area of water use—agriculture, industry and cities—demand has increased rapidly, and because of improved living standards world water demand has been growing faster than population: at 800 cubic metres a year, per capita use today is nearly 50 per cent higher than it was in 1950. Global water use has more than tripled in the same period, and now stands at an estimated 4,340 cubic kilometres per year. But we actually rely on a far larger share since water bodies dilute pollution, generate electricity and support fisheries and wildlife.

Worldwide per capita water supplies, which drop as population grows, are a third lower now than in 1970. In an increasing number of countries, population has surpassed the level that can be sustained comfortably with the water available. Hydrologists designate water-stressed countries as those with annual supplies of 1,000-2,000 cubic metres per person. When the figure drops below 1,000 cubic metres, nations are considered water-scarce—that is, lack of water becomes a severe constraint on food production, economic development and protection of natural systems.

Today, discounting water flowing in from neighbouring countries, twenty-six countries, collectively home to 232 million people, fall into the water-scarce category. As many of them have very high population growth rates, their water problems are deepening fast. Africa has the largest number of water-scarce countries, but the Middle East is the most concentrated region of scarcity in the world, and tensions over water rights there could ignite during this decade.

Other parts of the world have not been spared. Symptoms of water stress exist, not just in the water-scarce countries, but in parts of water-wealthy ones as well. When groundwater is used

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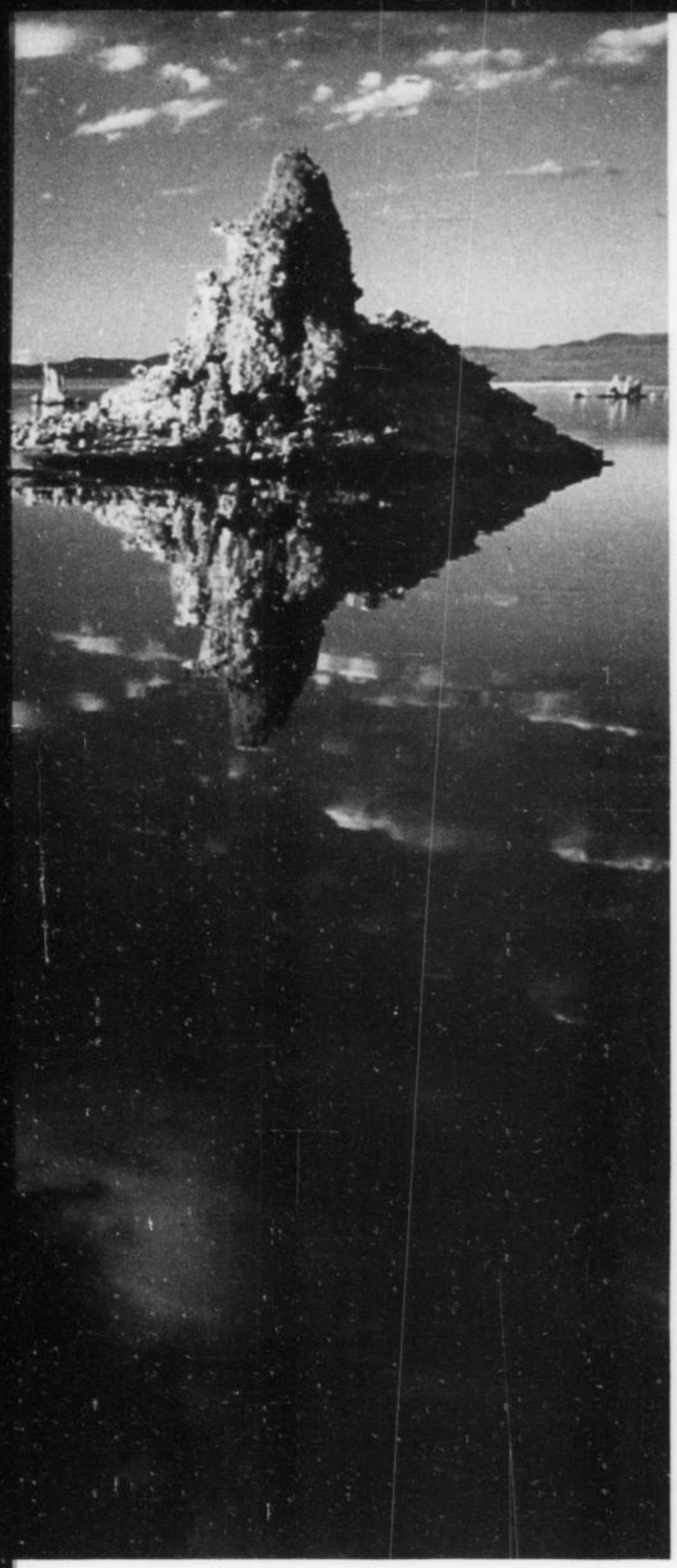


Left, Mono Lake in California.
Below, crocodiles in a reserve in Thailand.

faster than nature replenishes it, water tables fall and eventually the underground supply becomes too expensive to keep tapping and too salty to use. Overuse of groundwater is now endemic in parts of China, India, Mexico, Thailand, the western United States, North Africa and the Middle East.

FOSSIL GROUNDWATER DEPLETION

Some of the most troubling cases of unsustainable groundwater use involve "fossil" aquifers, underground reservoirs that hold water hundreds or thousands of years old and that receive little replenishment from rainfall today. Like oil reserves, these aquifers are essentially nonrenewable. Farms and cities that depend on this water will eventually face the problem of what to do when the wells run dry.

Saudi Arabia, for example, now mines fossil groundwater to meet 75 per cent of its water needs, and that dependence is growing as a result of government efforts to encourage large-scale wheat production in the desert. Though the country imports barley and other food crops, it became self-sufficient in wheat in 1984, and has since joined the ranks of the world's top wheat exporters. In early 1992, King Fahd authorized payments totalling $2.1 billion for 1991's record four-million-tonne wheat crop, which was worth only one fourth as much at the world market price.

Groundwater depletion in Saudi Arabia has been averaging about 5.2 billion cubic metres a year, and that rate is projected to increase by nearly half during the 1990s. At this rate the supply would be exhausted in fifty-two years. At the faster extraction rates projected for 2000-2010, it would dry up much sooner, and even before that happens the groundwater will likely become too salty to use without expensive treatment. Thus, little of Saudi Arabia's grain can be considered a reliable portion of the long-term food supply—either for Saudis or for those countries receiving its exports.

Other places dependent on fossil groundwater include Libya and the northwestern corner of Texas, where the amount of water in that state's portion of the Ogallala aquifer—the largest in the world—has already been diminished by a fourth. In Beijing, water tables have been dropping 1-2 metres a year, and a third of the wells have reportedly gone dry. Groundwater pumping in Mexico City exceeds recharge by 50-80 per cent, which has led to falling groundwater levels, aquifer

compaction, and land subsidence that has caused the famous Metropolitan Cathedral to slump.

As demands continue to rise and water supply projects get more difficult to build, water budgets are becoming badly imbalanced in many regions. From southern California to Israel, from northern China to parts of India, shortages are becoming chronic and rationing a way of life. In China, for instance, planners project that Beijing's total water demand in 2000 could outstrip available supplies by 70 per cent. Israel's annual water use already exceeds its renewable supply by some 300 million cubic metres, or 15 per cent. With the projected influx of new immigrants in the coming decade, its yearly water deficit will worsen greatly.

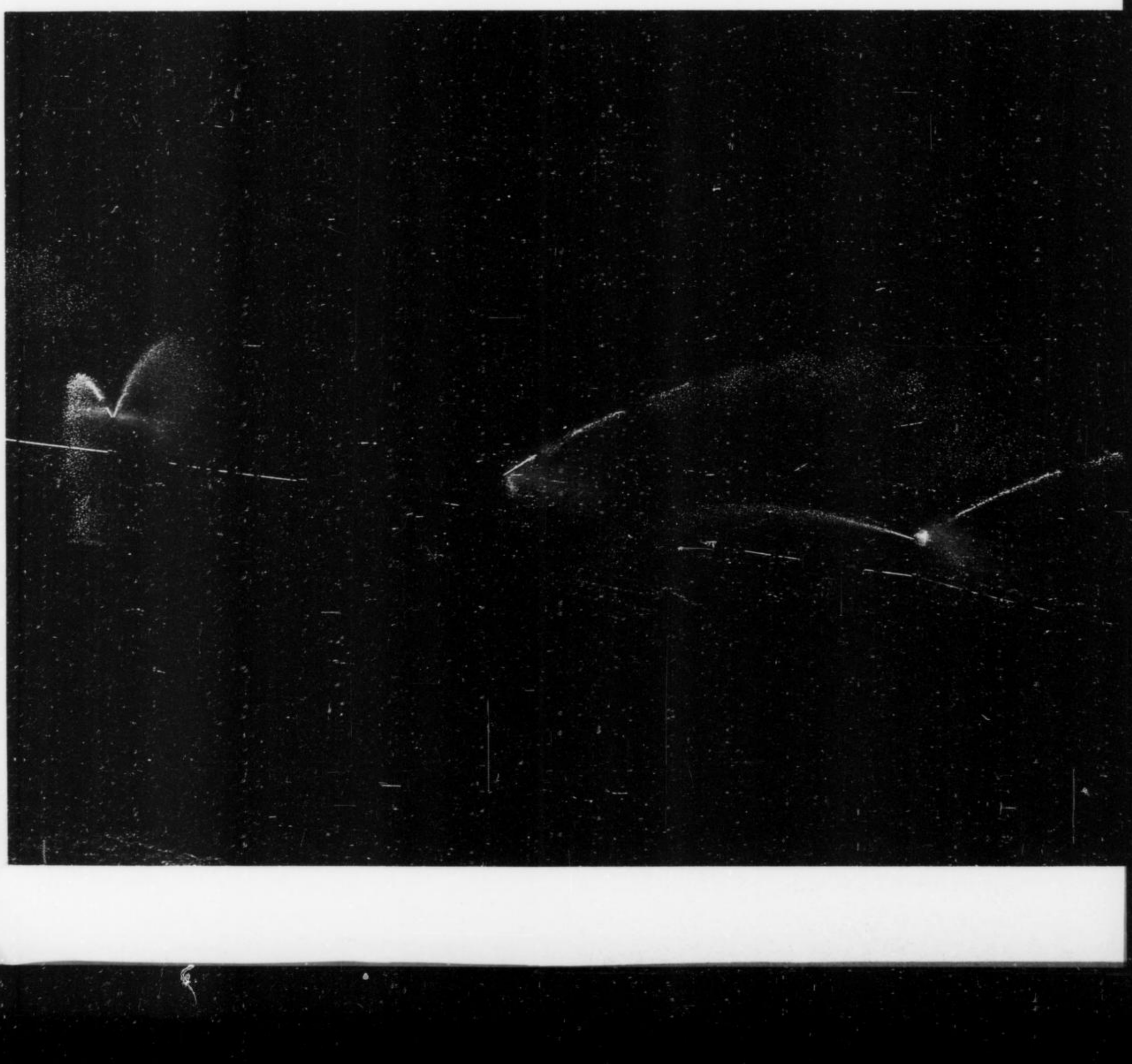
DAMAGE TO THE AQUATIC ENVIRONMENT

Shrinking groundwater reserves, falling water tables and projected demands that far exceed available supplies are clear signals of water stress, but perhaps the most worrying sign of trouble comes from examining the health of aquatic environments. The damming, diverting and polluting of watercourses have wreaked havoc on the world's wetlands, deltas, lakes and riverine habitats. Of all imperilled biological species, aquatic fauna is undoubtedly at greatest risk.

The shrinking Aral Sea is but the most dramatic in a long list of natural areas destroyed, degraded or at grave risk from human use and abuse of water—a list that includes California's Mono Lake, south Florida's Everglades, Spain's Donaña wetlands and Sudan's Sudd swamps, places that are home to astounding numbers and varieties of bird and wildlife species.

All these species are at risk from the degradation of the environment. In North America alone, the American Fisheries Society lists 364 species of fish as endangered, threatened or of special concern. An estimated one-third of the continent's fish, two-thirds of its crayfish and nearly three-quarters of its mussels are now "rare or imperilled".

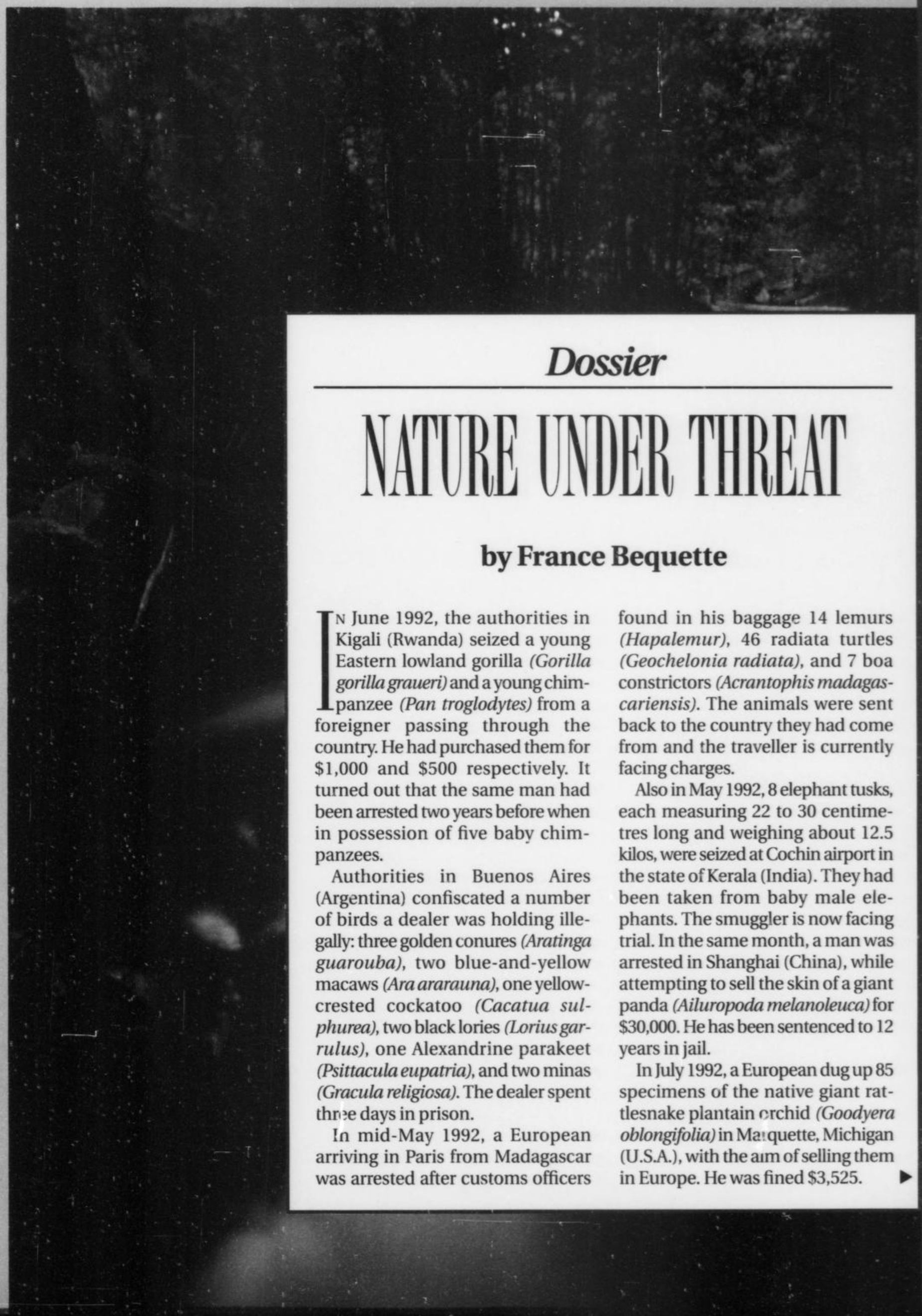
A distressing conflict has emerged over two of water's roles: as a commodity, and as a key life-support for all species. This duality calls out for a fresh approach, one that pays greater respect to the vital functions of this precious element. ■



Irrigated land in Kenya.

GREENWATCH

THE UNESCO COURIER - MAY 1993



Dossier

NATURE UNDER THREAT

by France Bequette

In June 1992, the authorities in Kigali (Rwanda) seized a young Eastern lowland gorilla *(Gorilla gorilla graueri)* and a young chimpanzee *(Pan troglodytes)* from a foreigner passing through the country. He had purchased them for $1,000 and $500 respectively. It turned out that the same man had been arrested two years before when in possession of five baby chimpanzees.

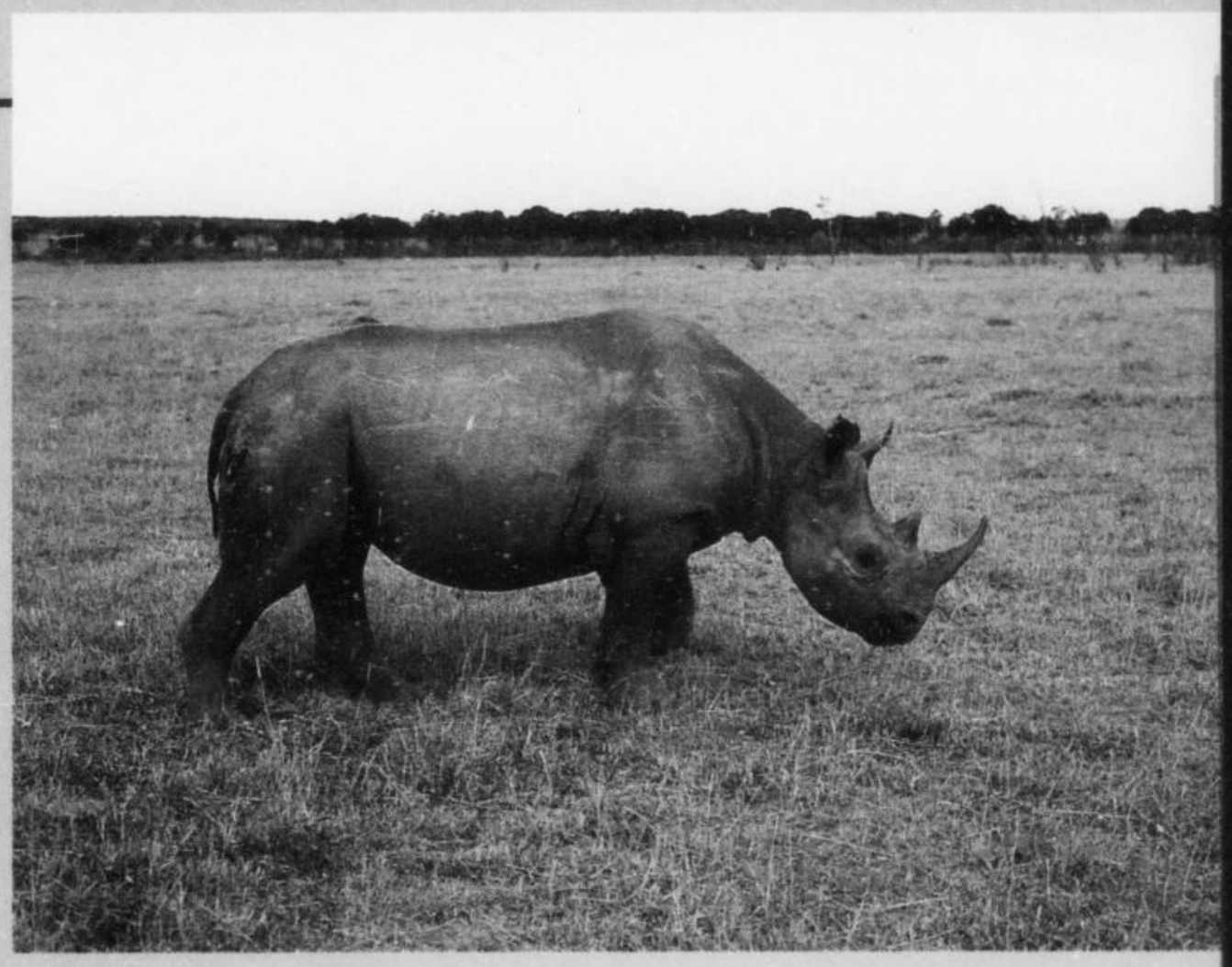
Authorities in Buenos Aires (Argentina) confiscated a number of birds a dealer was holding illegally: three golden conures *(Aratinga guarouba)*, two blue-and-yellow macaws *(Ara ararauna)*, one yellow-crested cockatoo *(Cacatua sulphurea)*, two black lories *(Lorius garrulus)*, one Alexandrine parakeet *(Psittacula eupatria)*, and two minas *(Gracula religiosa)*. The dealer spent three days in prison.

In mid-May 1992, a European arriving in Paris from Madagascar was arrested after customs officers found in his baggage 14 lemurs *(Hapalemur)*, 46 radiata turtles *(Geochelonia radiata)*, and 7 boa constrictors *(Acrantophis madagascariensis)*. The animals were sent back to the country they had come from and the traveller is currently facing charges.

Also in May 1992, 8 elephant tusks, each measuring 22 to 30 centimetres long and weighing about 12.5 kilos, were seized at Cochin airport in the state of Kerala (India). They had been taken from baby male elephants. The smuggler is now facing trial. In the same month, a man was arrested in Shanghai (China), while attempting to sell the skin of a giant panda *(Ailuropoda melanoleuca)* for $30,000. He has been sentenced to 12 years in jail.

In July 1992, a European dug up 85 specimens of the native giant rattlesnake plantain orchid *(Goodyera oblongifolia)* in Marquette, Michigan (U.S.A.), with the aim of selling them in Europe. He was fined $3,525. ▶

NATURE UNDER THREAT



A rhinoceros in the Amboseli reserve (Kenya). Hunted for their horns, rhinoceroses are now an endangered species, with a estimated worldwide population of only 11,000.

▶ Volumes of cases like these could be quoted, all of them bearing witness to the violence done to wildlife on a scale that has brought some species to the brink of extinction. In response to this threat, a Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was signed in Washington on 3 March 1973. The Convention came into force on 1 July 1975, and so far it has been ratified by 118 states. The CITES Secretariat, based in Lausanne (Switzerland) is attached to the United Nations Environment Programme and is financed by the Parties to the Convention. Endangered species are listed in three Appendixes to the Convention, in order of the degree of protection they are afforded. Appendix I prohibits all international trade in elephants, giant pandas and coelacanths, for instance. Appendix II authorizes a controlled international trade in members of the cat family, crocodiles, corals, and orchids. Appendix III restricts international trade in some species from certain countries, such as hippopotamuses from Ghana, or black bears from Canada.

Extreme cruelty

Wild fauna and flora face two major threats: the destruction of their habitat and unrestricted commercial exploitation. CITES provides signatory states with the legal means to repress a traffic that is motivated by the lure of profit and often involves acts of revolting cruelty. To take one example, park rangers often come across the bloody corpses of elephants with their tusks ripped out. Baby elephants are slaughtered for their "milk teeth", which weigh scarcely a kilo, compared with the average 12.6-kilo weight of an adult tusk.

Specialists agree that elephants are an endangered species, but views differ as to the size of the surviving population. There were a reported two million elephants in Africa in the 1970s. Today the figures vary between 350,000 and one million, depending on the sources, with about 100,000 killed each year.

There are several reasons for the decline of the African elephant (*Loxodonta africana*). One is the use of firearms, which are much deadlier than traditional hunting methods. Others include the change in vegetation and the drying up of many watering holes as a result of the periods of drought that have struck the southern Sahel over the past twenty years. Deforestation and desertification have destroyed many habitats. Demographic pressure and the extension of farmland have altered the elephants' migration patterns.

When people are forced to compete with wild animals in order to survive, a real problem of priorities arises. In Burkina Faso, for instance, villagers complain that elephants empty their water holes and trample their crops. Similar conflicts exist in southern Cameroon, where elephants eat the manioc and bananas that the Pygmies grow in small plots on the edge of the forest.

It is all too easy for people in Western countries who are quite happy to shoot the wild boar that wreak havoc in their fields to insist on protection for animals that cause them no harm. Yet solutions to the dilemma do exist. One is to pay compensation to those who suffer loss. This is what happens in Burkina Faso, although the budget for the purpose is quite inadequate. Another solution could be to protect the elephants by confining them to reserves, although the feasibility of this is questionable.

Nazinga is a ranch in Burkina Faso near the border with Ghana. It consists of 94,000 hectares of wooded, swampy ground inhabited by warthogs, large herbivores and elephants. Between 1984 and 1989, the elephant population rose from 216 to nearly 500. According to Olivier Jean, a veterinarian at the Rural Development Institute in Ouagadougou, every year the animals destroy 20 per cent of all trees under 40 centimetres in diameter in their search for food, an activity on which, according to the Worldwide Fund for Nature, they spend 18 to 20 hours a day.

For the local people, who are among the poorest in the world with

a per capita income of less than $140 a year, the ranch is a tempting prospect. Hunters by tradition, they regard the roan antelope as fair game. An elephant tusk, which can fetch as much as $175 per kilo, represents a fortune. A distinction should be made between killing animals for food and poaching on an industrial scale. Some poachers

operate in commandos, spotting elephant herds from helicopters and slaughtering them with automatic weapons. The rangers, outnumbered and armed only with old rifles, are powerless to stop them.

When the elephant was transferred from Appendix II to Appendix I of the Washington Convention in 1989, it was hoped that it would become impossible for poachers to sell their booty. Not so. Although the trade in elephants, dead or alive, has theoretically been banned, customs officials regularly seize shipments of ivory, as well as the horns of rhinoceros—another endangered species—hides, and live animals as well. The World Conservation Union, an intergovernmental agency with its headquarters in Switzerland, keeps updated lists of endangered species together with registers of protected sites around the world. It also monitors States Parties' compliance with the terms of CITES.

Poaching and smuggling

Traffic, which was founded in 1976 by the World Conservation Union and is based in Cambridge (United Kingdom), is another vigilant watchdog. The cases reported in its bulletin, also named "Traffic", show that regulation of a formerly free trade has led to the development of bizarre forms of smuggling. Among the examples cited are suitcases full of parrots with their beaks and wings bound by tape; five baby pythons hidden in a pair of socks; parakeets and birds' eggs sewn into the lining of articles of clothing. Freight shipments have also produced a crop of surprises, such as the consignment of Bibles which, on examination, proved to have been hollowed out and to contain young rattlesnakes. Last year, a case of wild birds containing jabirus and crowned cranes arrived in the Netherlands by air from Tanzania via Moscow. The case had been transported upside down and six of the nineteen birds were dead.

In Swaziland, the rhinoceros's fate is hardly more enviable. Only 13 white rhinos and 6 black rhinos are left, but they are still attracting poachers. The reason is the belief, widely held in the Orient, that powdered rhinoceros horn has aphrodisiac properties. Bears and giant pandas are killed for their gall bladders, which feature in the Chinese pharmacopeia. Juju markets in Africa display gorilla skulls, the skins of big cats, lion penises and dried birds, all sold as ingredients for potions or as good luck charms.

The problem is a complex one. What steps can be taken when tradition clashes with the idea of protecting living species? How can people be made to respect the 2,500 animal and 35,000 plant species included in the Washington Convention when, for example, a scarlet macaw *(Ara macao)*, which is on the endangered list, can be bought for $100 in South America and sold for $6,000 on the U.S. market? Political determination by states, an uncompromising commitment on the part of airline companies, special training for customs officials, and exemplary punishments for smugglers could at least reduce such attacks on the planet's biological diversity. ■

FRANCE BEQUETTE
is a Franco-American journalist specializing in environmental questions. Since 1985 she has been associated with the WANAD-UNESCO training programme for African news-agency journalists.

11,000 Rhinos **(1992), a sculpture by the American artist Jude Burkhauser, is a cry of alarm against the threat of extinction hanging over many animal and plant species. The detail opposite shows the horns, which are moulded out of plaster and painted in red ochre.**

SAVING THE INDIAN TIGER

The operation launched in 1973 to save the tigers of India is helping to keep up the numbers of this endangered species. At the latest count there were 4,334 animals in 1989, up from 4,005 in 1984, living in 18 reserves covering an area of 28,017 square kilometres. This is one of the biggest successes scored by the World Wide Fund for Nature (WWF), a nongovernmental organization with 4 million members and 28 national branches, which has carried out 5,000 programmes and invested some $250 million in nature conservation. ■

A FRIEND IN NEED

In Burkina Faso, a priest and five laymen travel through the bush, giving farmers advice after carefully listening to what the elders of the community have to say. Marin Terrible, a member of the White Fathers missionary society, is a former natural science teacher who arrived in Burkina Faso in 1973, at a time of famine following a year of drought. He carried out a botanical survey of the country's ligneous vegetation, and drew a map of it. He also compared Landsat satellite images with aerial photographs taken in the 1950s. His findings were alarming but the situation did not seem irreversible. Now when Father Terrible and his team are invited to a village, they take with them strips of cloth which are wound around two poles and are painted with familiar scenes that provide a basis for discussion. The team also produces an illustrated almanac full of sensible advice drawing on traditional knowledge. Typical entries include how to make a pulley system for a well, how to build small earth embankments to collect rainwater, and how to frighten away locust swarms. Father Terrible was invited to the Earth Summit in Rio, but unfortunately he fell seriously ill and was unable to attend. ■

A 'SLEEVE-PUMP' FOR A SAFE WATER SUPPLY

Although Colombia has plentiful supplies of groundwater safe for drinking, one-third of the rural population draws its water from unprotected rivers, streams and wells. With the help of a $500,000 grant from the United Nations Development Programme and active government support, 40,000 people living in small communities across the country have now been provided with safe water. A nongovernmental organization, the Las Gaviotas Centre, has been working for over 20 years on low-cost technologies such as the so-called "sleeve-pump", which can draw water up from a depth of 1 to 40 metres and requires little physical effort to manipulate. Pipes made of recycled plastic are used to run the water to homes, a rare luxury in this extremely poor region. ■

FERTILIZER FROM WASTE

Marta de Oliveira Prado teaches in a government school on the outskirts of Pelotas, an industrial town in the south of Brazil that is badly affected by pollution. In a letter to the *Courier*, she explains that the children in her class live in such extreme poverty that they often have to go out to work at the age of four or five. Some families survive on what they can scavenge from waste dumps, and this gave Marta de Oliveira the idea of teaching her pupils how to make organic fertilizer from garbage (see photo left). ■

A WORLD OF WASTE

Sustainable development links quality of life for everyone with the quality of the environment we share. The waste generated by rampant consumption in the industrialized countries is harmful to the developing countries. One person in the North consumes from 14 to 115 times more paper, from 6 to 52 times more meat, and from 10 to 35 times more energy than a person in a developing country. So much plastic flotsam now litters the oceans that nearly 2 million seabirds and 100,000 marine mammals perish each year by choking or by becoming entangled in it. ■

PROS AND CONS OF ECO-TOURISM

The Asian and Pacific region, under the pressure of a rapidly growing population, has turned to eco-tourism as a way of boosting foreign earnings. Unfortunately, it is paying a high price. Nepal, for instance, whose high peaks attract growing numbers of mountaineers, has been inundated with rubbish. Every year, thousands of visitors go mountain climbing or trekking in Sagarmatha National Park at the foot of Mount Everest, leaving behind metal cans, plastic debris and other types of waste, and burning large quantities of firewood, which is desperately scarce in the region. There appears to be no ready answer to this problem. ■

'MY PLANET IS MY BUSINESS'

"My planet is my business" is the motto of the Ushuaïa Foundation, which was established on 15 December 1990 by French television director and presenter Nicolas Hulot, under the sponsorship of the Fondation de France and with backing from the French power utility Électricité de France, the chemical firm Rhône-Poulenc, and the city of Paris. The Foundation states that its purpose "is to change our attitude to nature by making it better informed, more sympathetic, and more respectful." It organizes "Discovery Missions" in France and elsewhere in the world for groups of young people and adults selected on grounds of motivation. The aim of the Missions is to study the major ecosystems and the phenomena that govern them, with the help of scientific experts. Twice a year, the Foundation provides financial support for environmental projects that wish to publicize their findings. Applications should include a 15-line summary description of the project and relevant details about those engaged in it. Applicants should also specify whether they are seeking a financial grant (in which case a detailed budget should be submitted), a sponsorship arrangement or scientific counselling. Please write to:

Fondation Ushuaïa,
32 Avenue Charles de Gaulle,
F-92200 Neuilly-sur-Seine,
France (Phone 33 1 46 41 03 03;
Fax 33 1 46 41 00 42). ■

VETIVER GRASS, A CHECK AGAINST EROSION

When planted in rows, vetiver grass forms a thick hedge and weaves a dense web of roots that can bind the soil as deep as three metres beneath the surface. It adapts to a wide variety of climates and environments, and has been known and used for centuries in China and India. It can withstand fire and overgrazing, is resistant to most diseases, repels snakes and rodents, and is vulnerable only to cold. It slows down rainwater runoff and hence stops the vegetation cover from being washed away, thereby preserving soil fertility and productivity. There is also a financial advantage: while the construction of anti-erosion barriers costs an average of $500 per hectare, planting vetiver grass costs less than $30 per hectare. The World Bank has already contributed $500,000 to vetiver grass projects. ■

THE MIRACLES OF LOVE

The French Romantic historian Jules Michelet (1798-1874) was the author of a monumental body of work in which he acclaimed the heroism of peoples fighting for their freedom. He was also a passionate lover of nature. In L'Insecte *(1857), the man who spoke out for the proletariat also made the case for the humblest members of the animal kingdom.*

LOVE has wings. Mythology is absolutely right. The fact can be demonstrated literally, without metaphor. For a brief moment nature displays a restless urge to fly to the beloved. Each creature transcends itself, all rise towards the light, all go hunting on the wings of desire. Alluring colours further bespeak the inner fire. All are on display, all aim to please.

The butterfly seems to look at you with the great eyes of velvet that adorn its wings. Beetles of every kind, like mobile stones, astonish you with their fiery glitter, the energy that burns within them. And then, from the deepest shadows, naked and unveiled, the flame of love explodes in scintillating stars.

Strange transfigurations take place at that moment. From behind the humblest masks, in violent contrast, the most splendid characers emerge.

An obscure marsh grub, inert, surviving on cunning, becomes a brilliant amazon, the elegant winged warrior we call the dragonfly (*Libellula*). The only creature of its kind to express the complete freedom to be found in flight, it is to the insects what the swallow is to the birds. Who has not watched its thousand varied movements, as it turns and turns about over meadow or stream in the endless circles it describes with its blue-green wings? What seems at first sight a random flight is in fact not random at all; it is a hunt, an elegant and rapid extermination of thousands of insects. What looks like a game is really the fierce absorption of a brilliant warrior-being seeking nourishment for its time of love.

Don't think these riches are just the gifts of golden climes, that the brilliant ball-gowns these creatures don to love and die are no more than some passing reflection of the Sun, the all-powerful decorator whose rays coppered the enamelling, the jewels we admire on their wings. Another Sun entirely, one that shines for all the Earth, even to the chilly pole, plays a bigger part, and that is love. It exalts the inner life in them, brings out all their power and, on the appointed day, makes the final bloom burst forth. The sparkling colours that delight us are the creatures' energy made visible, articulate and eloquent. They are the pride of an entire life which, having reached its summit, stretches out in triumph, wishing to spread and bestow itself. They are the transmission of desire, the imperious prayer, the urgent appeal to the beloved.

In pallid, temperate climes, you will still find these brilliant liveries you might have imagined tropical in their hue. Who has not seen the cantharis burst forth beneath our dull and indecisive skies? Even in the gloomiest wastes where summer is only a moment long, love—as if to spite the Sun and the bare and barren land—raises beings of sumptuous splendour, opulent in their adornment and their dress. Abruptly, wretched Siberia sees princes and great lords parade among the insect race. The harsh Russian climate does not prevent enormous carabids, pitiless hunters, prouder than Ivan the Terrible, from decorating themselves in green morocco, black, violet or dark blue pinpointed with jet. Some, usurping the colours of the robes of emperors and of tsars, even strut about in purple bordered with Byzantine gold. ■

■ *The extract on this page appears in an anthology entitled* Compagnons du Soleil *("Companions of the Sun") co-published (in French) by* UNESCO, *Editions La Découverte (Paris) and the Fondation pour le progrès de l'Homme. The anthology was prepared under the general editorship of the African historian Joseph Ki-Zerbo, in collaboration with Marie-Josèphe Beaud.*

Climate of uncertainty

by Igor A. Shiklomanov

Climate changes resulting from human activity will have serious implications for the distribution of the world's water

Above, the Perito Moreno glacier (Argentina).

SOME scientists already foresaw in the nineteenth century that the progress of civilization and the growth of industry and energy consumption that went with it might soon affect the world's climate.

It was only in the 1980s, however, that an unprecedented warming of the atmosphere was observed. Average temperatures rose from year to year to reach the highest point since records began to be kept in 1850. It became increasingly difficult to put this phenomenon down to mere climatic variations. Even the most sceptical climatologists began to concede that global warming was a reality, and public opinion has generally grown used to that idea.

Many countries have set up national research programmes or joined in programmes co-ordinated by various international bodies—including UNESCO—to look into climatic changes brought about by human activities. A round-up of the findings of this research, prepared by a group of specialists drawn from various countries, was approved by the second World Climate Conference, held in Geneva in November 1990.

This research shows that, if present rates of population growth and industrial development are maintained, the air temperature is likely to increase by 2 or 3 °C in the next twenty to thirty years. The warming effect would be greatest, as much as 5 or 6 °C, in the cold and temperate zones, and less marked in the tropical and subtropical zones.

The possible effect of these temperature increases on the hydrosphere—that part of the Earth covered by water and ice—is a matter for serious concern, since the hydrosphere is particularly sensitive to climatic changes, to which it reacts immediately. Any alteration to the hydrological cycle has a direct impact on economic development and on the environment in many parts of the world, causing an upheaval in the conditions in which the local populations live.

In the higher latitudes, the Arctic and Antarctic in particular, there will be an increasingly rapid melting of the snow and ice, in which enormous quantities—over twenty-four million cubic kilometres—of fresh water have been stored up over hundreds and thousands of years. This will cause a gradual rise in the levels of the oceans, which could amount to a metre within the next

century and much more thereafter, with obviously disastrous consequences for low-lying coastal regions such as the Netherlands or Bangladesh, as well as for such major conurbations as London or St. Petersburg.

As the air temperature goes up, evaporation from both land surfaces and water surfaces will increase too. The atmosphere will become more humid, the processes of the hydrological cycle will speed up and rainfall may increase. In short, this change in the climate will profoundly disturb all the workings of the system whereby the waters of the Earth and of the seas are held in balance.

SHRINKING RIVERS

Rivers provide almost 90 per cent of the world's supplies of fresh water. Hydraulic engineering projects aimed at regulating their flow have considerably affected the volume of water they carry, a large part of which (over 4,000 cubic kilometres a year) is now drawn off for industry, urban water supplies and, in especially large quantities, irrigation. The creation of large artificial lakes and reservoirs, often as big as natural lakes, upsets normal streamflow and evaporation patterns over vast areas. Increased water consumption is also tightening the pressure on water resources. In certain densely populated regions, rivers have "lost" from 20 to 30 per cent of their normal flow and some, like the Amu-Darya and Syr-Darya in the former Soviet Union, as much as 90 per cent.

The effects of rising temperatures on river discharge are likely to be very serious, especially in the arid zones. Annual discharges in such regions will plummet, even if the air temperature rises by only 1 or 2 °C and rainfall drops by no more than 10 per cent.

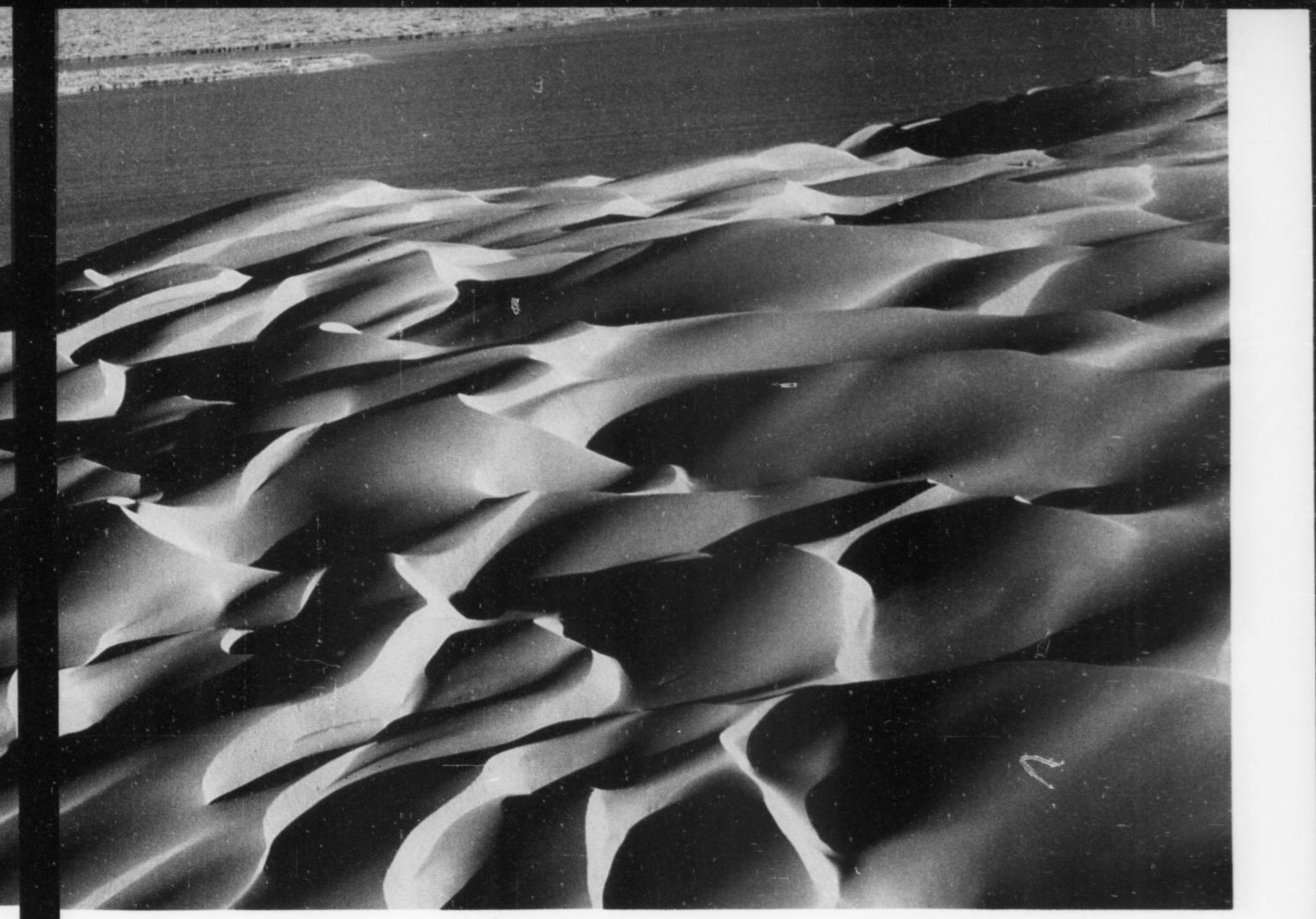
Variations in precipitation have an even more decisive impact than temperature increases as such. If the latter were accompanied by even a slight reduction in rainfall in the arid and semi-arid regions which comprise 30 per cent of the land-mass in Europe, 60 per cent in Asia and vast areas of Africa and Australia, the world's water problems would become much worse. The change would affect not only annual flows but also seasonal flows, especially in the temperate zones, where the springtime peak discharge is of great importance.

From its source in the mountains of central Asia, the Amu Darya flows through the deserts of the Turan Lowlands towards its mouth on the southern shore of the Aral Sea. Its discharge has sharply diminished in recent years.

A temperature rise of 2 °C, leading to more rapid melting of snow because of warm spells in winter, would increase the discharge of the great rivers of Russia and Ukraine—the Volga, Dnieper and Don—by 50 to 100 per cent in winter, but would decrease it by 25 to 30 per cent in the spring. Similar conclusions have been reached for Scandinavian countries (Finland, Norway and Sweden), and for certain river basins in Poland, Belgium and the mountain regions of the United States. In all these areas, and over much of the northern hemisphere as a whole, seasonal and annual river discharge would be particularly affected by air temperature changes.

These scenarios are of little relevance for the warm and arid zones or for the tropics, where forecasts sometimes contradict one another. Palaeoclimatological data tend to suggest that there would be only slight increases in air tem-

Water pollution in the Kowloon district of Hong Kong.



peratures, accompanied by sizeable increases in rainfall, but these optimistic conclusions are challenged by other climate predictions, based on global climate modelling, which on the contrary envisage sharp rises in air temperatures and only slight rises in rainfall.

DANGEROUS FLUCTUATIONS

Research into the effects of global warming on the hydrological cycle also shows another factor of major importance—possible modifications in the maximum and minimum flow levels of streams and rivers. On the basis of empirical data and theoretical calculations foreseeing a twofold increase in the proportion of carbon dioxide in the composition of the atmosphere, it has been demonstrated that, in New Zealand for example, the rainy seasons will become wetter and the dry seasons drier and longer, resulting in increased variations in seasonal streamflow. According to the same calculations, the maximum values for rainfall and streamflow in Australia will rise and the minimum values fall, summer and winter alike. River levels are likely to rise significantly in the north-west of the United States, north-eastern Canada, the north and west of Great Britain and the northern part of western Europe. The widest fluctuations will probably occur in Japan and California.

This alternation between extremes—higher river levels and more frequent droughts—is fraught with economic and ecological risks, especially for urbanized areas and agricultural regions, and could make it necessary to rethink the distribution of irrigated farmland and to relocate most of the water-consuming industries. The warm and arid areas of the world could well run into serious water-supply problems that in places could degenerate into conflict.

To deal with all these problems, the authorities in some regions may have to revert to the mammoth hydraulic engineering schemes that were popular in the 1960s and 1970s: the building of enormous reservoirs, river diversions, the redistribution of water resources and increased exploitation of fossil aquifers.

It is obviously no longer possible to close our eyes to the potential consequences of man-made climatic changes and variations in water resources, consequences that call for extensive research, especially if precise, detailed forecasts are to be established for each part of the world—an extremely complicated task that requires close collaboration by scientists the world over, in the interests of all humanity. ■

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Shifting sands

by Harold Dregne

Human activities as well as climatic conditions are responsible for desert advance. They can also help to curb it

DESERTIFICATION has been defined as land degradation in arid, semi-arid and dry sub-humid areas resulting mainly from adverse human impact.

It was long thought to be largely due to the occurrence of droughts. Not until preparations were being made for the United Nations Conference on Desertification, held in Nairobi, Kenya, in 1977, and convened in an attempt to prevent a recurrence of the human misery and loss of livestock that occurred during the severe West African drought of 1969-1973, did it become clear that more than drought was involved in the degradation of grazing land.

After all, droughts were an inevitable part of the climatic regime in the drylands. Indigenous plants had adapted to the sequences of wet and dry years that affect all arid regions. They prospered in the wet years, then called upon their adaptive mechanisms to carry them through the dry years. It was only when humans tipped the balance against them by over-grazing and wood-cutting that vegetation was no longer able to handle the moisture stresses brought on by drought.

Grazing land is not alone in being subject to desertification, and a lot of damage has occurred on both rain-fed and irrigated crop land. Most descriptions of desertification are centred on grazing lands simply because pastoralism is the dominant land use in nearly 90 per cent of the world's drylands.

Rain-fed crop lands become exposed to the threat of accelerated (human-induced) water and wind erosion as soon as the native vegetation is destroyed when land is cleared for cultivation. Controlling erosion requires good management skills because crop production usually leaves land bare and unprotected during some part of the year. Salinization—the accumulation of salts in the irrigation water or in the original soil—is an additional threat to irrigated crop land and is usually the consequence of inadequate soil drainage.

Vegetation degradation, water erosion, wind erosion and salinization are the major desertification processes in the drylands. However, compaction of cultivated land by machinery probably does as much, if not more, damage in many countries. A land degradation process that can be locally important is the accumulation in the soil of toxic substances such as heavy metals (lead, chromium, etc.), pesticides and industrial wastes. The adverse effect of such toxic substances is not so much on the soil as on the humans and animals that feed on plants growing in contaminated soil.

What is the extent of the problem? The results

Left, rice terraces in the Philippines.
Above, a herd of cattle near Lake Magadi (Kenya).

of a study made for the United Nations Environment Programme indicate that, over a total area of some 5,160 million hectares, a quarter of the irrigated land, half of the rain-fed crop land and three-quarters of the rangeland are desertified.

CAN DESERTIFICATION BE HALTED?

One interesting outcome of the desertification study is the finding that there is an inverse relation between the severity of desertification and the intensity of land use. Rangelands represent a low-intensity land use but have proportionately more degraded land than the irrigated lands, where land-use intensity is high. Rain-fed crop land, where land-use intensity is medium, has an intermediate proportion of degraded land. This implies that intensive land use produces a more sustainable agriculture than does extensive use.

Methods of halting further land degradation of all kinds and of reversing vegetation degradation and salinization are known. Reversing water and wind erosion is difficult, or impossible for all practical purposes, since erosion causes removal of soil, which requires decades, if not centuries, to replace by natural means. Soil compaction by machinery is readily controllable.

Improving salt-affected irrigated land is a relatively uncomplicated process and cost/benefit analyses of salinity control are fairly easy to calculate, given the fact that the main cost is, usually, to provide an effective drainage system. Reclamation of the soil, once the reclamation system is operating, is generally complete in three years or less. Sometimes it takes only a few months.

In principle, grazing land improvement is simple. All that is needed, in most cases, is to reduce the grazing pressure on the vegetation. In some situations seeding is necessary to ensure that desirable perennial plants can be established rapidly. Unfortunately, reducing grazing pressure is not easily implemented because fewer livestock mean lower returns to the pastoralist. Improving grazing lands in the dry sub-humid climatic zone can be done much more rapidly than in the arid climatic zone. Where it would perhaps take five to ten years of good management to restore range productivity—if weather conditions were favourable—in the dry sub-humid zone, it might well require fifty years or more in the arid zone.

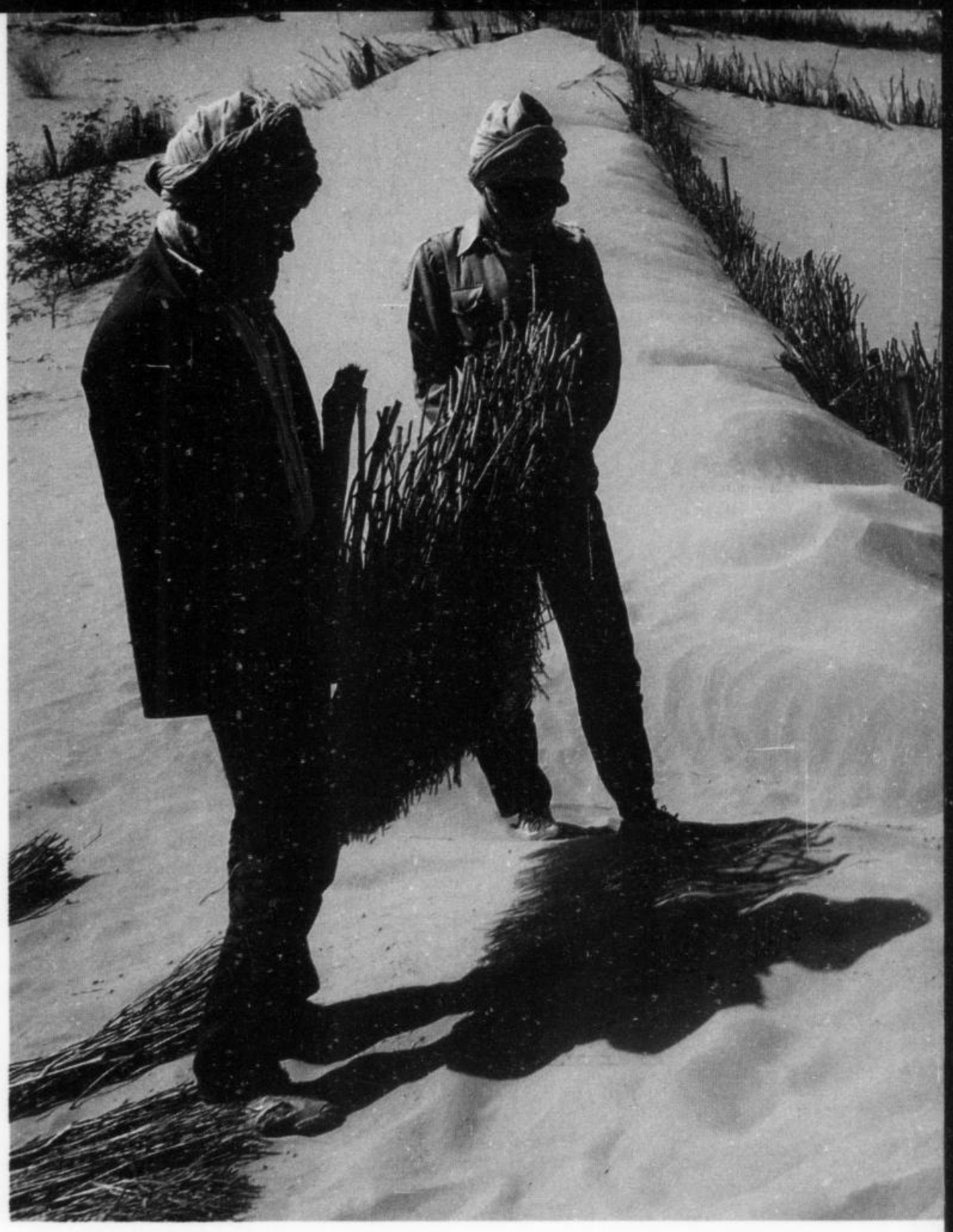
Proven practices to control erosion by water include terracing, strip cropping, contour cultivation and minimum tillage. The two principal objectives of such control practices are to protect the soil from the impact of raindrops on bare soil and to slow the down-slope movement of runoff water. Bench terracing, which has been

practised for centuries on steep slopes in many countries, particularly in Asia, is very effective but is extremely labour-intensive.

Wind erosion control is usually accomplished by building shelter-belts (wind-breaks), strip cropping, using tillage practices that roughen the surface, minimum tillage and spreading crop residues over the soil. In each case the objective is to slow the speed of wind movement at the soil surface, thereby reducing the eroding ability of the wind. One rarely used method of stopping wind erosion is to spray the soil with asphalt. Asphalt is selected as a last resort—it is expensive—in extremely arid regions where vegetation cannot be established.

Solid walls, wooden fences and a latticework of plastic strips are other devices that have been tried for erosion control. Shelter-belts consisting of a mixture of shrubs and trees are widely used. The major disadvantage of shelter-belts is the competition for water by tree roots extending into the crop field.

Nearly all degradation control practices are site specific—that is to say that adjustments must be made to fit local land, climate, economic and cultural conditions. Bench terracing, for example, is fine when soils are moderately deep and labour is cheap, but it is completely impracticable when soils are only moderately deep or labour is expensive. Similarly, minimum tillage is a highly effective water and wind erosion control practice that is only practicable if weeding can be done economically by hand labour or the timely application of herbicides.



As part of a fight-the-desert project in Mauritania, fences are built to keep the sand from blowing away.

THE SITUATION TODAY

My assessment of global desertification leads me to draw a number of conclusions. First, that grazing land deterioration in the drylands has been going on for centuries in some areas and more recently in all others. Rangeland productivity has probably levelled off nearly everywhere and will stay at a low level indefinitely. I see little likelihood that the current situation will change either for better or for worse. Grazing is a low-value land use that cannot pay for expensive improvement measures. Only governments can afford, for social or political reasons, to improve rangelands.

Second, there will be two opposite changes in salinization of irrigated land as water shortages become more acute. If the shortages lead to increased water-use efficiency, salinization will decrease. If the shortages are not met with practices to increase water-use efficiency, salinity will worsen. The sum of the two responses may well be to increase global salinization of irrigated land. There will almost certainly be an increase in dryland salinity, which, globally speaking, is not extensive as yet.

Third, water erosion is the major threat to long-term soil productivity. For all practical purposes, water erosion removes soil permanently. New soil material develops so slowly that it can take centuries to change rock into soil. Whereas gully erosion is readily observable, sheet erosion gradually wears away the soil mantle. There is little evidence of damage until, one day, a farmer notices that the soil on his hills is orange-coloured instead of the black it was originally. It is then that he realizes that erosion has robbed him of topsoil and that all he can do is to try to prevent further loss.

Fourth, wind erosion damage will be largely unchanged in the future. Wind erosion is a fact of life in the arid regions. Although there are many knowledgeable people who believe this to be a serious on-site problem, my view is that the damage is modest on a global scale. Local blowouts are one thing; they are very destructive, but not extensive. Off-site damage to buildings, highways, railways, machinery and human and livestock health is another matter.

Whereas water erosion apparently causes as much off-site damage (floods, reservoir sedimentation, water pollution, etc.) as on-site damage, wind erosion stands out as having much more severe off-site than on-site impact. The only known study of on-site/off-site wind erosion damage costs was done for the State of New Mexico, in the United States. That study concluded that off-site damage costs were about forty-five times greater than on-site costs.

My overall conclusion is that no great change in the extent and severity of desertification is likely in the immediate future. ■

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Crisis in the South

by Asit K. Biswas

As a result of poverty, population growth, urbanization and pollution, water management is set to become the most crucial natural resource issue facing the developing world

THE days when water could be considered a cheap and plentiful resource are virtually over, and many parts of the developing world are already facing a water crisis which is likely to intensify significantly during the coming decades. This crisis in the South is the direct result of four interrelated phenomena.

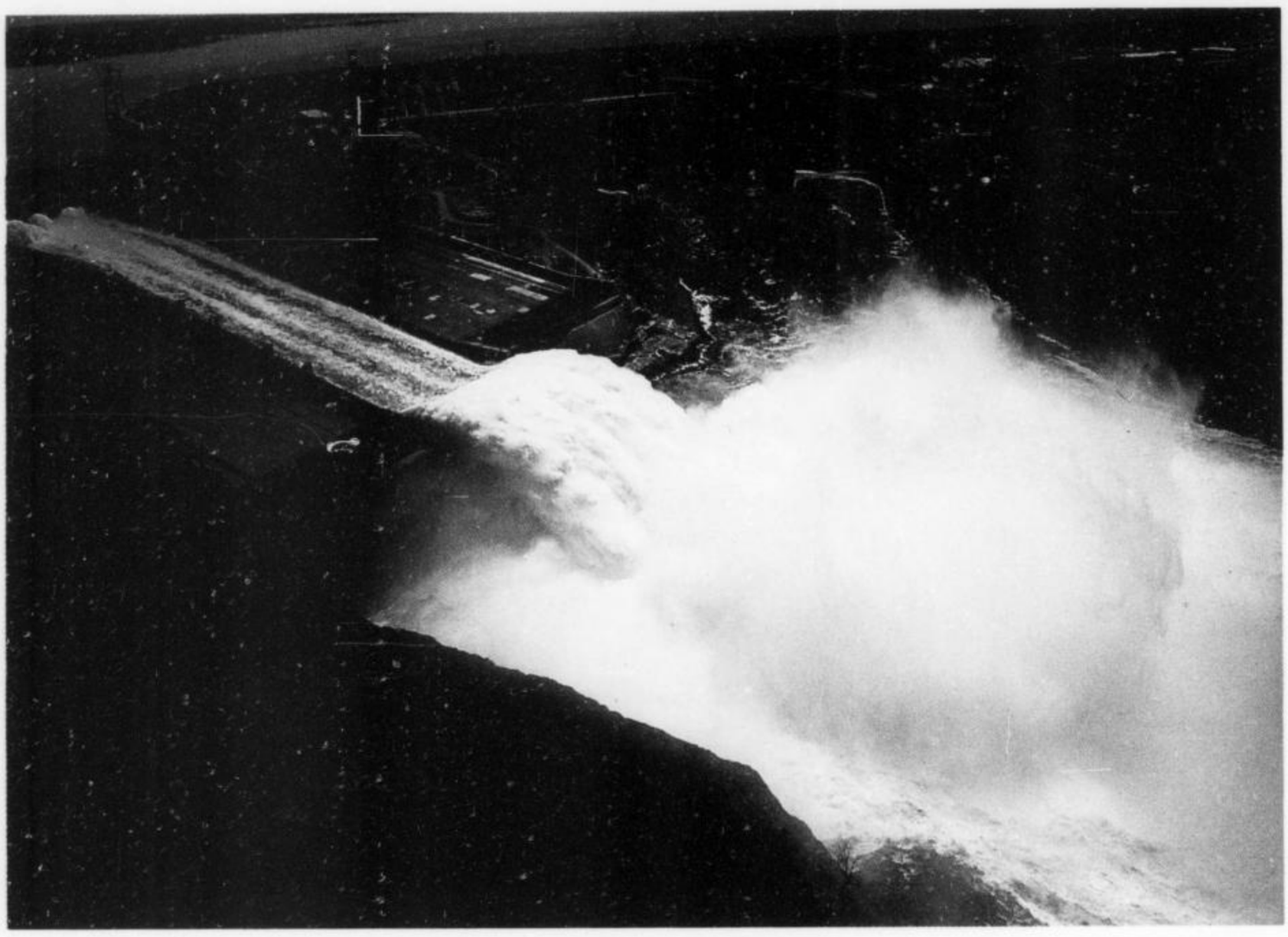
First, since nearly all the easily available sources of water have now been developed or are in the process of development, the unit costs of future projects are bound to rise. Meanwhile, many developing countries are saddled with very high levels of debt, and the amount of new investment available, both internally and externally, is limited. In addition, competition for available funds is intense.

Second, current estimates indicate that by the year 2050 world population is likely to double to 10.64 billion, of which developing countries will contribute nearly 87 per cent, or 9.29 billion. While there is no one-to-one relationship between population and water requirements, it is clear that with a substantial increase in population, water requirements in the South are bound to increase as well. Furthermore, past experience indicates that as standards of living rise so do per capita water requirements, and so if current poverty-alleviation programmes succeed, these requirements will increase further.

Third, as the impact of human activities increases, water is being contaminated by more and more waste products such as untreated or partially-treated sewage, agricultural chemicals and industrial effluents. Already many sources of water near urban centres of developing countries have been seriously affected.

The fourth major factor relates to the increasing delays in implementing new water projects that are likely in the coming decades owing to higher costs and lack of funds. Social and environmental factors will also significantly delay project initiation time, certainly more than in recent decades.

In the South there will be increasing pressure to make water management more efficient than ever before. However, the amount of time available for these improvements is likely to be short—certainly no more than a decade, or at most two. While technological problems may be comparatively easy to solve, political, institutional and social constraints are likely to be a very different matter. They may, in fact, pose the most difficult challenge for water management in the South in the twenty-first century.



The Itaipú dam on the Paraná River was built by Paraguay and Brazil.

Here are some priority areas for action:

▶ ***Raising the global profile of freshwater issues.*** Efficient water development and management will require significantly more capital than the countries of the South have access to at present. Until water is placed squarely on the international and national agenda, the necessary funds will not be forthcoming.

▶ ***The conservation and efficient use of water*** have only received lip-service so far. Since agriculture is by far the largest user of water, efficient irrigation management will undoubtedly be a major conservation option in the future. Although some progress has been made during the past decade, the overall level of efficiency is still far too low.

Considerable scope also exists for practising water conservation in the domestic and industrial sectors. In many towns and cities in developing countries, more than half the treated water is lost because of leakage. Design changes can significantly reduce water requirements in the industrial sector.

▶ ***Institutional strengthening and co-ordination.*** Most water management institutions in the South need considerable strengthening. In addition, nearly all countries must substantially improve the level of collaboration between institutions—at present water-related policies are developed in a fragmented fashion. At the international level, much better coordination is necessary between the multilateral and bilateral assistance organizations.

▶ ***Management of international water sources.*** The only major sources of water that remain to be developed are international in character, that is they are shared by two or more countries. Unless proper treaties are negotiated between co-basin countries, international water bodies are likely to be a fertile area of conflict in the future.

Very few objective in-depth analyses of international water bodies in developing countries are currently available. To a great extent international organizations have deliberately steered clear of the issue, mainly because it has been considered to be politically sensitive.

▶ ***Environmental considerations.*** The environmental aspects of water resource development need more attention.

▶ ***Research and training.*** Countries of the South have to forge better links with one another on research and training in water management. Currently, there is very little South-South knowledge and technology transfer. For example, even though countries like Egypt and India have many common water problems, and the various institutional, economic and technical constraints are somewhat similar, Egyptian water professionals have very little knowledge of Indian practices and vice versa. Considerably more needs urgently to be done in this area.

Equally, international organizations need to develop clear and cost-effective training strategies for water professionals of the South. Is it preferable, for example, to bring them to France or the United States for a two-week training programme, when the same amount of money could provide more than a year's training at a good Indian institution? Fundamental questions of this type have yet to be asked, let alone answered properly. ■

ASIT K. BISWAS,
Indian-born Canadian specialist on water resources development and environmental management, is the president of the International Society for Ecological Modelling, based in Copenhagen (Denmark). A former scientific advisor to several United Nations agencies and many governments, he is the author of a prolific body of work which has been translated into 13 languages.

The Aswan High Dam, 25 years on

by Mahmoud Abu-Zeid and M. B. A. Saad

FROM time immemorial life in Egypt has revolved round *Nahr an-Nil*, the River Nile, the longest river in the world and the dominating feature of Egypt's topography. The ancient Egyptians recognized the importance of the waters of the Nile to their economy and kept records of the river level with the aid of nilometers—gauges formed by graduated scales cut in natural rocks or stone walls.

It was therefore quite natural that, in the push for development in the immediate post-war years, the Egyptians should turn once again to the Nile for solutions. Thus was born the concept of the construction of a new dam designed to control the Nile water for the expansion of cultivation, to iron out the impact of both drought and floods and to provide for the generation of hydro-electric power.

Begun in 1959 amid a furious controversy about the possible ecological consequences, the Aswan High Dam (one of the largest in the world) and its associated power station have been fully operational since 1970. Lake Nasser, the reservoir formed upstream as a result of the construction of the dam, is over 500 kilometres long, with an average width of 12 kilometres. It penetrates some 200 kilometres into the Sudan and covers an area of about 6,500 square kilometres.

■ *The balance-sheet*

The dam was conceived as an ambitious, multipurpose project aimed at improving irrigation and water resource control and development, increasing cultivation, providing protection against high floods and severe drought, and facilitating navigation, fishery expansion and electric power generation, while minimizing harmful effects on the environment and the country's rich cultural heritage.

What is the situation after nearly a quarter of a century of full-scale operation? In Upper Egypt some 380,000 hectares of cultivated land have been brought under year-round irrigation, which means that two or three harvests can be produced annually instead of one. Water is available for a variety of crops, even in low-flood years, and this has resulted, for example, in the quadrupling of the area under rice cultivation. Drainage has improved in all cultivated areas and productivity has increased by from 20 to 50 per cent. Some 420,000 hectares of new land have been brought into cultivation since completion of the High Dam, and it is estimated that a total of over a million hectares could eventually be reclaimed.

From the point of view of flood and drought protection, the Dam appears to have been an unqualified success. Human lives and cultivated lands were successfully protected during the high-flood years of 1964, 1967 and 1975, and sufficient water was available in both Egypt and the Sudan during the low-flood years of 1972, 1979, 1983 and 1984.

The vast size of Lake Nasser has led to a multiplication of the fish population, which has become an important source of protein for Egyptian consumers. The High Dam power station is now one of the main pillars of industrial development in Egypt. It supplies energy to many new factories in the Nile valley and to many farms and villages in the rural areas.

■ *Some negative side-effects*

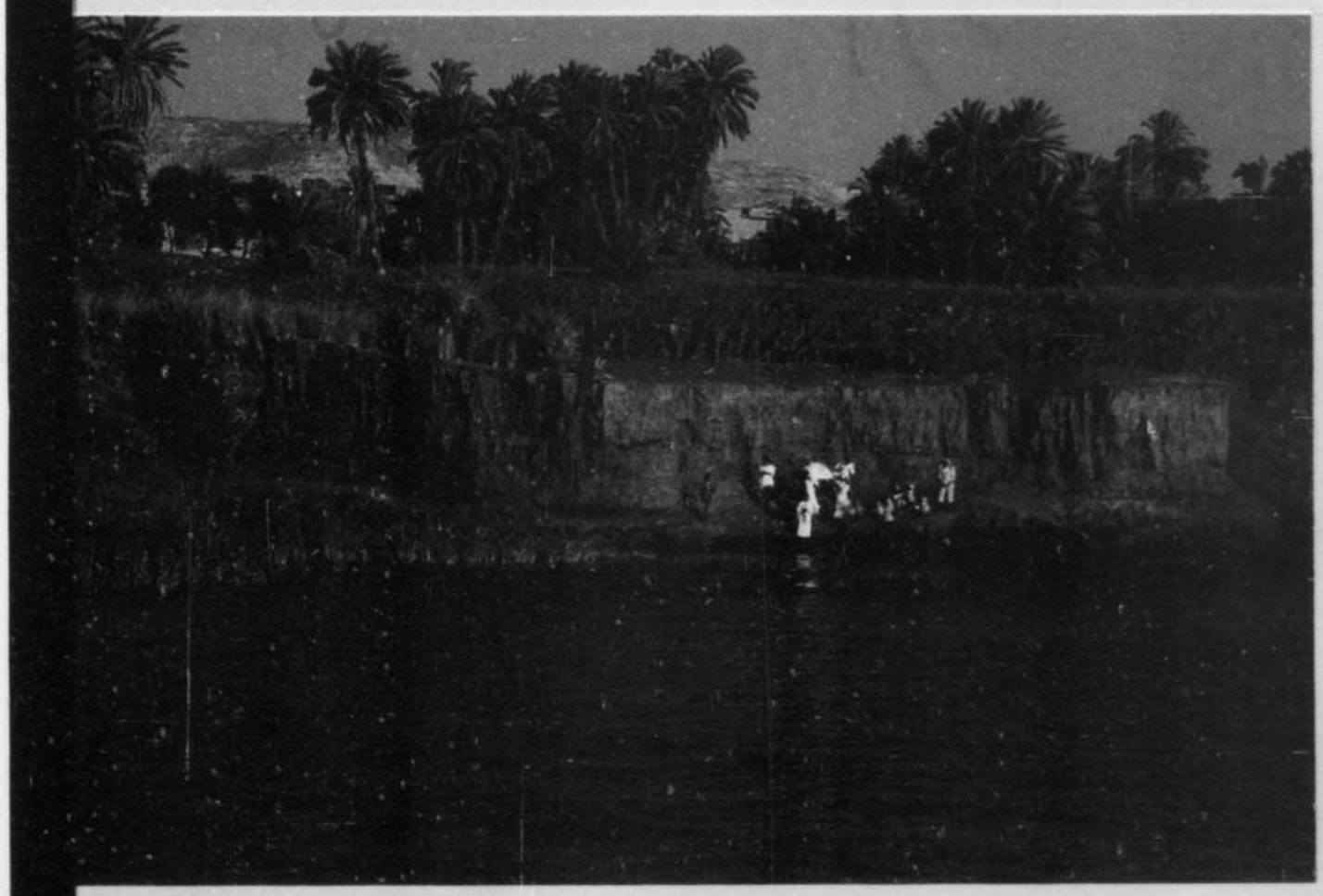
Since completion of the Aswan High Dam water flowing downstream from it has become silt free and this has had a number of deleterious side-effects:

- Degradation and lowering of the river bed, affecting the stability of existing hydraulic structures across the Nile—in particular the Isna, Nag Hammadi and Asyut barrages (although recent studies suggest that the level of degradation may be much less than was previously thought).
- Lower water levels and seepage of irrigation water from nearby cultivated land, leading to the collapse of parts of the river banks.
- Raising of the water table due to excessive use by farmers of irrigation water which is now available all the year round.
- Some deterioration in water quality and increased salinity due to long-term storage in the lake upstream of the High Dam.
- A massive increase in aquatic weeds of various types (82 per cent of water courses, canals and drains are now heavily infested by weeds).

This sudden weed invasion, perhaps the most serious side-effect of the construction of the High Dam, is ascribed to the following factors: silt-free water allows deeper sunlight penetration, thus encouraging weed growth; the annual floods that used to occur before construction of the High Dam used to flush the channels and push weeds to the Mediterranean; with two to three crops being cultivated annually, land fertilization has increased, causing eutrophication of drains and canals.

■ *Health impacts*

Since the construction of the High Dam a number of plans have been drawn up for the economic development of the region along the shores of the reservoir. These include the establishment of human settlements, industrial development and tourism and recreational projects. There is a serious risk that such schemes will affect the water quality and the aquatic ecosystem of the reservoir. Furthermore, deterioration in the quality of the water of the reservoir would affect downstream river users. ■



The Nile at Isna, near Luxor in Upper Egypt.

MAHMOUD ABU-ZEID AND M. B. A. SAAD
are respectively president and secretary-general of the Centre for Water Research (Cairo).

The liquid of the gods

Venerated for its divine qualities since the time of the Pharaohs, water is still invested with a rich symbolism in black Africa today

by Camille Talkeu Tounounga

A wealth of symbolic meanings—source of all life, purifying substance, regenerating element—is attached to water in Black African traditions.

In the creation myths of the Dogon of Mali, water is a divine green seed that impregnates the Earth so that it brings forth twin green beings, half man, half serpent. Also according to Dogon mythology, impregnation presupposes that oil, the male seed, combines in the womb with the moisture of the vagina in a helix symbolizing the creative vibration.

Like their Bambara neighbours, the Dogon go further and assimilate water, the fertilizing seed,

to light and to the gift of speech, the creating Word. "Dry" water and "dry" words express the idea of thought, the idea of potentiality, both among humans and among the gods. Genesis occurred when the supreme celestial god Amma created in his likeness Nommo, the god of "wet" water. In music, oil symbolizes the melody and rhythm is represented by water, the word.

For these peoples, and in many countries of sub-Saharan Africa, water, the life principle, is closely involved in the rites accompanying childbirth. When the afterbirth is expelled, proving that the child has indeed been born, one of the midwives takes a mouthful of water and sprays it gently over the baby. The cool touch of the water makes it cry out—it has "officially" received the gift of speech.

Invested with divine properties throughout Africa since the time of the Pharaohs, water plays its part in the fertility of the fields and of all living beings and all things, but in addition each kind of water—rain, spring, river, pond, lake, sea, dew, water collected in a hollow tree—has a particular significance. According to the Bantu, creation took place in a great whirlpool or in a bed of reeds, somewhere to the East. The Fali of Cameroon associate water, the uterine element, with fish. Among the Bamileke of western Cameroon, fathers bless their daughters on their wedding day with water in which leaves of *fefe*, a kind of spinach symbolizing gentleness and harmony, have been steeped.

The cross device on the masks worn by these Dogon villagers of Mali is a symbolic representation of Amma, the supreme god of a cosmogony in which water plays a vital part.

CLEANSING AND HEALING

Purification, indissociable from initiation rites, cleanses the initiates of previous impurities, drives away evil forces and protects them. Among the Bambara, at the end of the initiation ceremony, the chief of the *kore*, the initiates' society, sprays a mouthful of water over the neophytes. They are then washed, first in the meeting-place of the *kore* by a former initiate, with water from the village's sacred pond, then a second time at the village's holy well.

The bellies of young Sara girls in Chad are also cleansed with water taken from a gourd and sprayed from their mothers' mouths, while Zulu girls, after being kept in seclusion for some weeks, take a ritual bath in the river and wash off the red clay with which they have daubed themselves.

Water, the abode of the spirits, plays a part in the voodoo ceremonies of Benin, Togo and Nigeria. It is a pervasive presence in Haiti, where voodoo, practised both publicly and in the family, is a way of rediscovering an identity that was profoundly disturbed when the ancestors of today's islanders were uprooted from Africa. Haitians believe that they can reconquer that mythical Africa whence all the spirits come, by way of subterranean waters that constitute a world of their own and teem with human activities of every kind. This is why magical properties are attributed to springs, rivers and waterfalls, and why water is poured out before the altar at the beginning of ceremonies, in order to summon up spirits from the underworld.

Water may also be at the root of the temporal and religious power exercised by groups of initiates, usually secret societies, which by supernatural means assume the magical attributes of water spirits. One such organization is to be found among the Duala, a people inhabiting the coastal region of Cameroon, who have a water ancestor, the *jengu*, represented in bygone days as a black man with long hair, bulging eyes and splayed feet and more recently as a long-haired white woman. The *jengu* confers wealth on men and fertility on women. It may take human form, manifesting its power by miracles and prophecies and acting as a counterbalance to the authority of the chiefs. Until the German colonization of this part of Africa, the *jengu* played an important political role among the Duala; revered as an ancestor, a *jengu* could marry into the nobility. Even today the *jengu* retains therapeutic powers, for although the old beliefs have all but disappeared from public life, they still survive in the context of illness and healing, in the form of invocations, states of possession or trance, and prayers.

PRAYERS AND PETITIONS

Water is a precious substance and when it is in short supply disasters may occur. The peasant's life depends on the rains. If they come late or not at all, or if they are too abundant, he performs again and again the rituals and invocations of which the fabric of rural civilization is woven. Many myths explain the origin of these practices.

According to the Diola of west Africa, in the beginning there were two divinities, Amontong, the god of drought, and Montogari, the rain god. They owned great flocks and lived together until one day they quarreled and came to blows. While they were fighting, Amontong's wives sent off their children with dried skins tied to ropes. Dragging the skins behind them, the children raised lots of dust, which became clouds, and the noise made by the skins became thunder. The gods discharged their shotguns at them, creating lightning. Then the children of Montogari took what remained of the dust and made rain. ■

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is a sociologist and anthropologist from Cameroon whose most recent publications are *Islam et négritude*, *Le nomadisme en Afrique, l'exemple des Peuls* and *Symbolique des masques en Afrique noire* (all 1993).

The forgotten ones

by Tassoum L. Doual

Women are Africa's front-line troops in the struggle for survival against drought, famine and war. They also have to fight for recognition of their crucial role in economic development

GETTING drinking water is a simple matter of turning on a tap in the countries of the North, but it involves a veritable assault course for most Africans—African women, to be more precise, since in addition to looking after the home and the children, cooking the meals and tending the crops, women are also burdened with this arduous task, which often means having to walk miles to fetch the precious liquid.

Africa is a continent of climatic contrasts, arid in some parts, rainy on either side of the Equator, and for twenty years or so it has suffered from disturbances in the normal weather patterns that have had disastrous effects, particularly in such regions as the Sahel. The Sahel receives very little rain, and the impact of inadequate rainfall is direct. Wells and streams run dry, crops and cattle die off, villagers abandon the land for the towns, malnutrition follows, infant mortality increases and outbreaks of water-borne diseases reappear. No reference to water in the African context would be complete without a

mention of river blindness, bilharzia, viral hepatitis, cholera and malaria.

Although the Sahel is the region worst affected, the Horn of Africa and southern Africa have also been ravaged by drought since 1991. Southern Africa is facing an unprecedented food-supply emergency. South Africa, traditionally an exporting country that kept its less fortunate neighbours supplied with cereals, is set to import grain in large quantities. Cereal production in the ten countries of the Southern African Development Co-ordination Conference (SADCC), which stood at twelve million tonnes on average, slumped this year by half, and eighteen million people face famine.

THE POOR RELATIONS OF DEVELOPMENT

Women are the first casualties of drought, famine and war. They have to struggle to keep life going in this nightmare world of ruin and desolation. Poverty drives the menfolk away to neighbouring countries or to swell the ranks of the urban unemployed, leaving women to cope alone with immense responsibilities. Deprived of traditional forms of support, they need new sources of income to ensure the survival of their families and communities, but illiteracy and lack of training invariably oblige them to seek employment in the informal sector.

Above, harvesting blue algae in Chad. Left, a woman carries water in Mali.

Their already precarious health situation has been further undermined, largely by frequent childbearing and chronic malnutrition. Their working hours (according to some estimates, women work on average 2,490 hours a year, as against 1,400 for men) have been made even longer by current shortages, which oblige them to go farther and farther afield in search of water and firewood—not forgetting the long treks they have to make with sick children to the few clinics that exist, where they have to wait for hours as they do at the well.

The efforts made and the aid provided during the 1980s as part of the United Nations International Drinking Water Supply and Sanitation Decade, have, it is true, started to bear fruit. Substantial resources have been mobilized for this battle, and a number of hydraulic schemes aimed at alleviating women's drudgery have been launched. The results have been uneven, but the lessons learned from the projects that have failed will certainly enable beneficial readjustments to be made in the future.

Despite this, and despite the fact that they are the most productive members of African society, women remain the poor relations of the economy, the outcasts of development schemes. They are acknowledged to have duties but seldom recognized as having rights. Due recognition should be accorded to the importance of their social and economic role, and they should be helped, by means of literacy teaching and training, to find paid employment, so that Africa can at last make progress towards "sustainable development with a human face". ■

Pumps of contention

CHAD is one country where women have to contend with both water scarcity and insecurity. The government, with the help of a few financial backers, installed water pumps in two northern regions, Guéra and Ouaddai, where drought is endemic. Attitudes being what they are, however, women were kept out of the management side of things. During public meetings, they maintained a disapproving silence or merely acquiesced politely. In the village of Mangalmé, they refused even to attend, saying they were not involved in "your pump business". After long discussions, they plucked up courage to say—even though the men were present—that it was up to those to whom the pump belonged to answer questions. It emerged from further discussion that the management committee, composed entirely of men, had been giving preference to water-sellers and herdsmen, obliging the women to go on drawing the water for household needs from the traditional wells. The wells were, however, from five to fifteen kilometres away from the village, and the women had to make the long journey weighed down with heavy water-jars attached to each end of a pole.

As for hygiene, we found out that in all the villages where there were pumps the runoff channel had been blocked to make a drinking-trough. The livestock drank stagnant water from it, or even out of the recipients that were being filled. When asked if their health had improved since they had drinking water, many of the women sarcastically replied that they were not doctors so they couldn't tell.

In another village, the men told us how satisfied they were. "Look," they said, "our womenfolk have grown bigger and more beautiful since the pump was installed. It's great to see them getting some rest. Let's hope it continues that way, because it seems the pumps often break down in other places." As regards these breakdowns, Mariam, a fifty-year-old woman, told us: "We have a great deal to put up with. It's really very hard to have to go ten to fifteen kilometres to fetch water. Night-time is for sleeping but we have to go and fetch water. Our daughters don't even have time to grow because we trail them around with us to teach them to put up with suffering. Thanks anyway for the pump, but if you really want to help us, show us how to repair it, then we'll be able to get it going again ourselves instead of having to go and look for a repairman forty-five kilometres away, often only to find he's left for the town. All the repairmen we've had left sooner or later. There's no work here, you know, so all the men leave." No expert could have put women's needs more clearly.

Water-supply schemes should help encourage the rural population to become self-sufficient in food production and slow down the drift to the towns. The installation of pumps in the villages has not, however, given a boost to fruit and vegetable growing and has not created new sources of income. The reason is that this aspect of the matter was not taken into consideration

Queuing for water in the Sudan.

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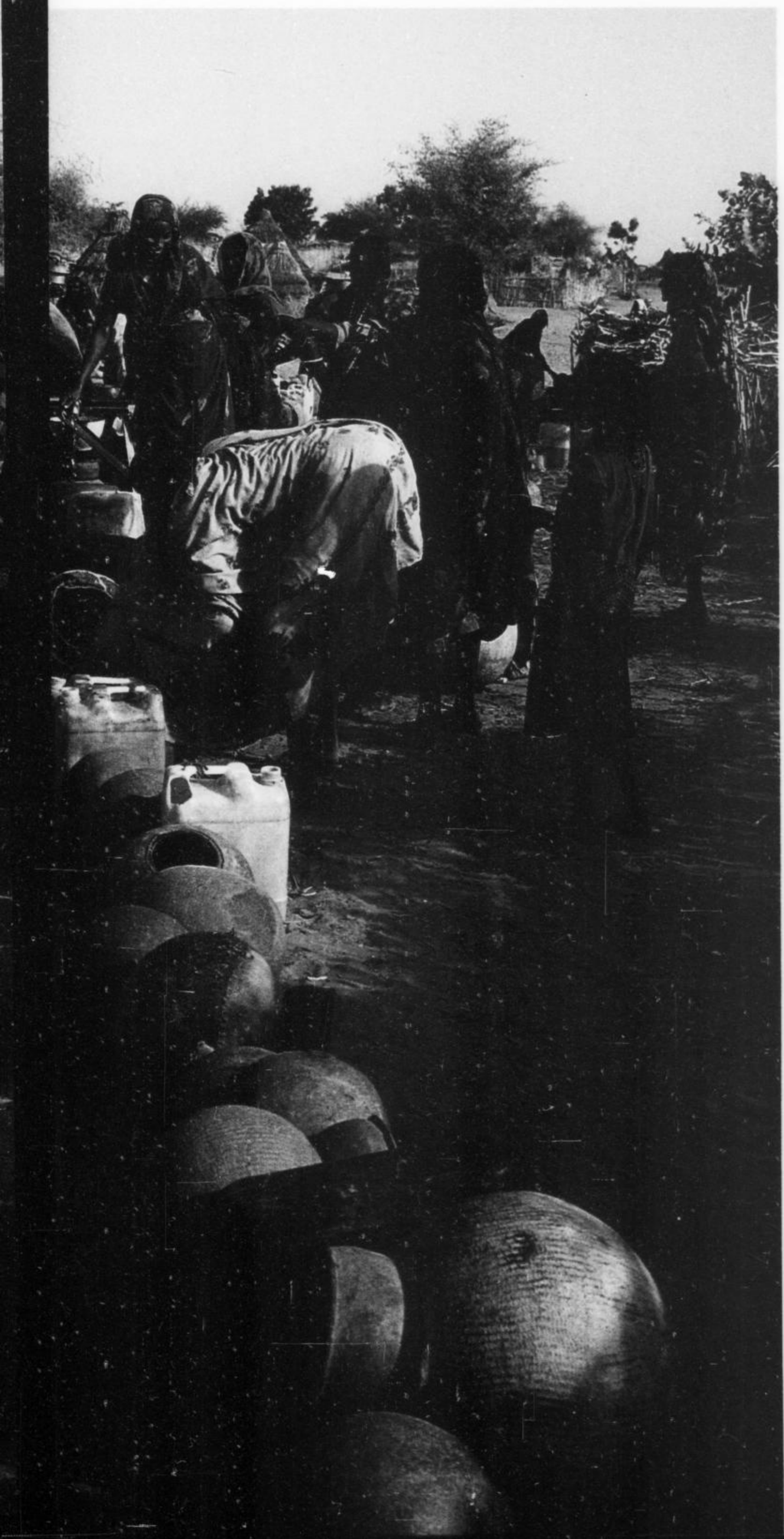
is a Chadian economist who is currently preparing a doctoral thesis on the socio-economic changes and the situation of women in Chad during the civil war. Among her publications in English is "Chad: Civil War and Development Prospects", which appeared in *Voices from Africa*, published by the United Nations Non-Governmental Liaison Service, Geneva, 1991.

by the people behind the schemes; raising awareness and getting the local population to participate—especially women, who after all are the main intended beneficiaries—are not high among their priorities. Yet as long as women continue to be left out of economic and social development, it will be difficult to achieve any progress in the villages. ■



Miracle algae

BARKADROUSSO is a little country town in the Kanem region of west central Chad. Its population is about 800, mostly women. The Kanem region used to be good cattle country, but drought has decimated the herds and made life very difficult. All the able-bodied men have gone, leaving behind the women, children and the elderly. Achta is one of these women. Aged about forty, she lives alone with her six children. Seven years ago her husband left to work in Libya, like so many other men. It is five years since he last came back. "God be with him," she murmurs, "we're still alive, thanks be to God and the *dihé*."

The *dihé* is the only form of wealth that the women of Barkadrousso possess. It is a blue alga, invisible to the naked eye, that grows in profusion in the natron-rich ponds of certain wadis. Very high in protein content—15 grams are the equivalent of 100 grams of meat—in mineral salts and vitamins, it is the staple food of the local population, cooked as a thick soup or made into a sauce.

On the day of the harvest, a hundred or so women gather around the pond with their containers. Many have their daughters with them. When the signal is given, they collect as much *dihé* as they can. Half of them have come more than fifty kilometres to Barkadrousso for the purpose.

At one time, most of the streams in the Kanem produced *dihé*, which the women sold, dried, at the market in Mao, seventy kilometres away. With the proceeds they bought tea, sugar and clothes. Nowadays the market traders gather the algae themselves. Achta says: "All the wadis around here have dried up. Ours is the only one left. God has been good to us. I don't hear from my husband any more. A lot of women are in the same situation. I'm old, but look at those two over there. They only have two children each and their husbands have been gone five years. It's a good job we have *dihé*, otherwise what would become of us?"

For these women, the blue algae have taken the place of husbands, parents and livestock. They provide their only source of income; they are mother's milk to their children. "Our children are not thin, thanks to the *dihé*, but look at the next village!" It is true that the children in Barkadrousso show no signs of malnutrition, unlike those in the neighbouring villages.

A plan drawn up by the Chadian authorities, and warmly welcomed by the womenfolk, aimed to replenish the dried-up wadis and produce algae to feed the local population. Three nongovernmental organizations from the developed countries were ready to provide funding for the project, but owing to the almost permanent insecurity that reigns in the region, it has yet to be implemented. ■

For 30 years UNESCO has played a leading part in the development of international hydrology

The role of UNESCO

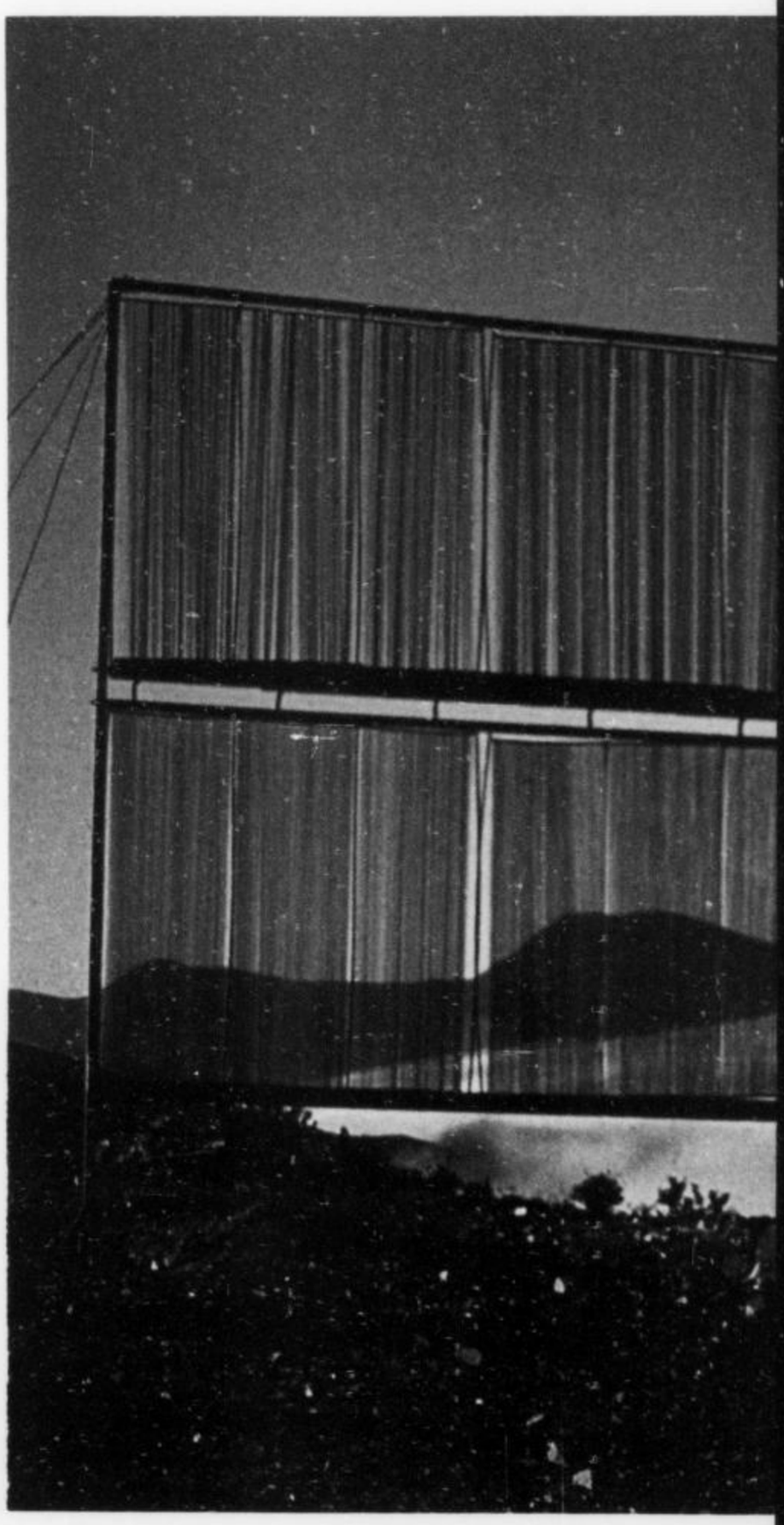
by András Szöllösi-Nagy

CIVILIZATIONS have always been strongly dependent on water. By now it should be clear to everyone that the converse is also true: vital water resources depend upon civilization or more precisely the "civilized" use of a finite and vulnerable resource. This two-way feedback underlines the strong need for co-operation. Well co-ordinated international collaboration is essential if we are to understand the processes occurring in the water cycle, to assess surface and groundwater resources, and to adopt an attitude that maintains the quality and quantity of water resources for generations to come. Recognition of these needs led to the launching by UNESCO of the International Hydrological Decade (IHD) in 1964, the first truly international scientific and educational effort in hydrology ever made.

One result of IHD was that hydrological maps containing hitherto unavailable baseline information were drawn up, particularly for water-short developing countries in Africa, the Arab States, Latin America and Asia. This work was made possible through the establishment of internationally accepted mapping techniques. IHD also developed regional water balances which later served as basic references for calibrating global-scale models. Hundreds of hydrologists from all over the world took part in this painstaking work. Techniques for assessing the environmental impacts of water projects were also developed.

One of the most important results of IHD was the setting up of training courses for post-graduates and technicians in hydrology and water resources. Every year some 500 participants, the overwhelming majority of whom come from developing countries, complete courses designed and taught under UNESCO's auspices.

But there was still much to be done, particularly in the application of scientific progress to the solution of practical problems. It was recognized that economic and social activities tend to aggravate difficulties arising from natural fluctuations in the hydrological regime, and that human impact on water resources increases with the spread of urbanization and population growth. In 1974, UNESCO therefore decided to launch a long-term International Hydrological Programme (IHP) with the aim of finding solutions to the problems of countries with different geographical and climatic conditions and at different levels of technological and economic development. The Programme is founded upon a network of



ANDRÁS SZÖLLÖSI-NAGY
is the Secretary of the International Hydrological Programme and the Director of the Division of Water Sciences of UNESCO.

National Committees (some 141 to date) and also on a strong partnership with the non-governmental scientific organizations. Over the years very close co-operation has been developed with the World Meteorological Organization.

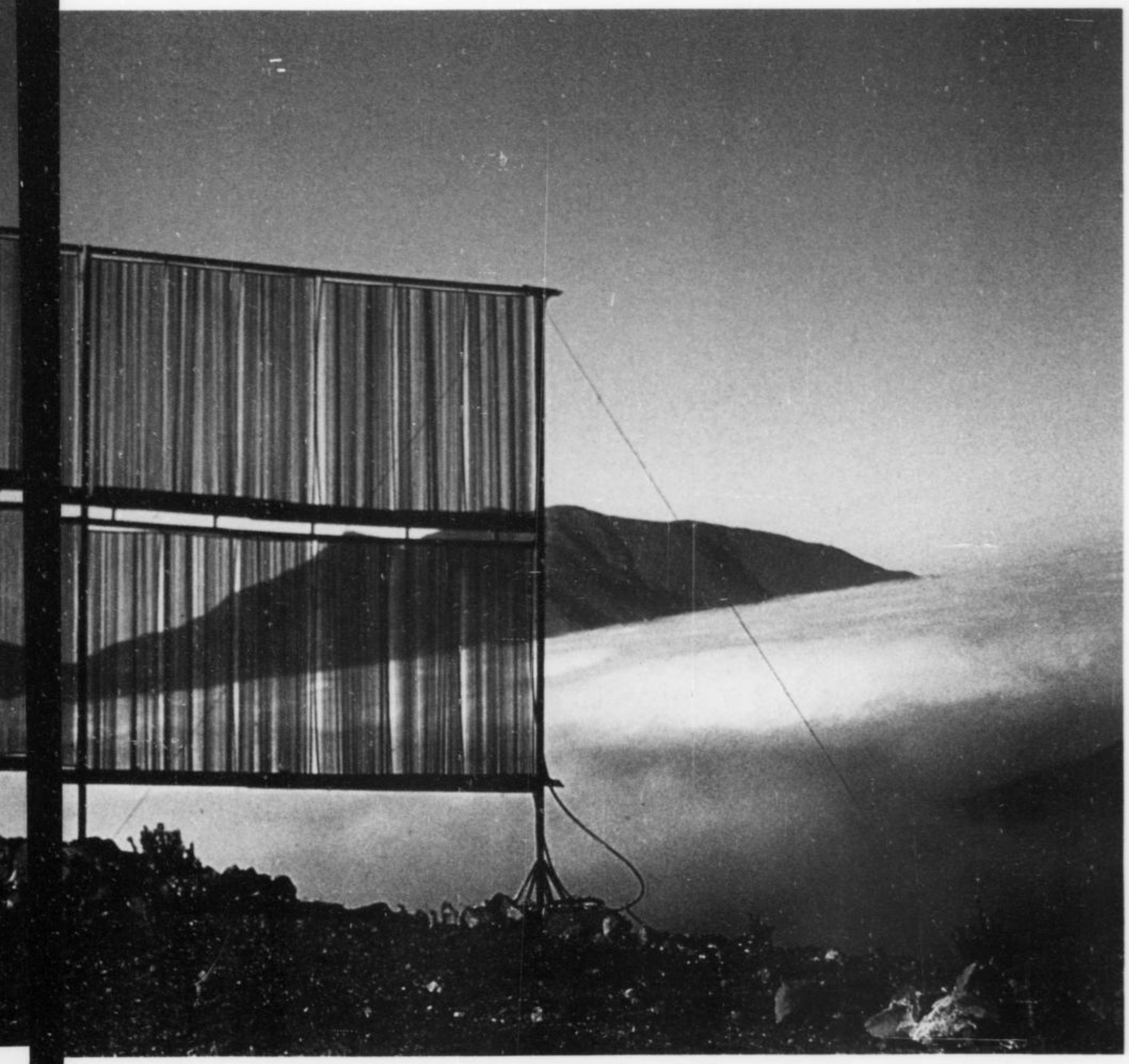
In the early years of the IHP (1975-1980), studies were carried out on hydrological parameters for water projects, hydrological aspects of droughts, changes in the hydrological regime due to human activities, hydrological problems related to energy development, the dispersion of pollutants in aquatic media, socio-economic aspects of urban hydrology, aquifer contamination and protection, and land subsidence due to groundwater abstraction.

A later phase of the IHP, which ran from 1984 to 1989, improved scientific knowledge of hydrological processes and parameters for water projects and led to a better understanding of human influence on the hydrological cycle, including the environmental impact of water projects. The development of education and training, public information and scientific information systems gained new momentum.

Recognition of the dangers of a possible climate change on the distribution of water resources in space and time as well as the need for sustainable development set the theme for the current phase of the IHP (1990-1995).

One of the least understood aspects of global change is the land phase of the hydrological cycle. In order to understand this phase, studies of the processes whereby water is transported through the atmosphere-vegetation-soil system must be carried out on different scales. Together with the International Geosphere-Biosphere Programme, the IHP is currently trying to solve this problem.

We must come to appreciate more fully that our rapidly changing and increasingly vulnerable environment will only be protected if it is the focus of outstanding legal, organizational and scientific efforts. Without doubt, the need for hydrological science as a base for integrated water management will increase in importance. The International Hydrological Programme is seeking to satisfy this need, with the over-riding goal of helping nations to help themselves. ■



The strips in this screen serve to trap moisture from clouds and mist. The technique, developed in the Andes, is now also used in India and the Gulf region.

NEWSBRIEFS

UNESCO AND THE FIGHT AGAINST AIDS

Ten years after the discovery of the HIV virus by his research team at the Pasteur Institute in Paris, Professor Luc Montagnier has created a World Foundation for Aids Research and Prevention, under the auspices of UNESCO. The Foundation is seeking to mobilize private initiatives against a scourge which has taken on tragic dimensions, especially in the developing world. Its first objective is to help establish pilot centres where people who are HIV positive can be given laboratory examinations and clinical tests that could rapidly evaluate the effectiveness of new drugs. The Foundation, which has received support from several non-governmental organizations, scientists and religious authorities of different faiths, is also planning to carry out social work, initially by providing education for Ugandan orphans whose parents have died of Aids.

SUPPORT FOR MAURITANIAN WOMEN'S PROJECT

The Arab Gulf Programme for United Nations Development Organizations (AGFUND) has offered to support a UNESCO project to create a Women's Handicraft and Development Centre at Oualata, a village in the Mauritanian desert. Women in the village, which has a population of a thousand, face a hard struggle to make a living since most of their menfolk are migrant workers in the capital city of Nouakchott and have left them to cope as best they can. The women have already formed a co-operative, but would like to increase production, improve the quality of their traditional handicrafts, and raise farm animals. The aim of the project is to restore a village building to house the Women's Centre, where literacy classes can be held and women can receive training in improved techniques for working with matting, skins and carpets.

LITERATURE WRIT LARGE

"Humour is inseparable from humankind and, like it, is universal and changing, individual and social". So reads the preface to *Cuentos divertidos* ("Amusing Tales"), a collection of ten humorous stories recently published by UNESCO and the Madrid publishing house Editorial Popular. The collection inaugurates UNESCO's Large Print series (*Letra Grande* in Spanish) of extracts from works by some of the greatest names in Iberian and Latin American literature. The large-print format aims to meet the needs of the newly literate and people who have difficulty in reading. Seven other books, including a second collection of stories, *Cuentos andinos* ("Andean Stories"), will be published in the series before the end of the year. The books are on sale at the UNESCO Bookstore, 7 Place de Fontenoy, 75700 Paris; or can be ordered from UNESCO Publishing: Tel. (33 1) 45 68 49 73; fax. (33 1) 42 73 30 07.

A NEW HYDROLOGICAL GLOSSARY

A second (revised) edition of the International Glossary of Hydrology has been published jointly by UNESCO and the World Meteorological Organization. It provides definitions and translations of 1,800 terms in English, French, Spanish and Russian, with an alphabetical index in the four languages and the universal decimal classification for hydrology. The new edition, on which an international group of hydrologists has been working since 1984, is an attempt to standardize the vocabulary used by hydrologists and research institutions in order to facilitate exchanges of information and international co-operation. The glossary is available from scientific bookstores or by mail order from UNESCO Publishing, Sales Division, 7 Place de Fontenoy, 75382 Paris 07 SP, France. The price of 200 French francs includes postage by surface mail.

THE HISTORY OF CLIMATE CHANGE REVEALED BY ARCHIVES

To understand and predict climatic changes it is useful to have an idea of what the climate was like hundreds if not thousands of years ago. With this in mind, a pilot project was launched in 1990 by UNESCO, the World Meteorological Organization (WMO), the International Council of Scientific Unions (ICSU) and the International Council on Archives in order to collect historical climate data from archives. Archival data can help to provide a broader picture of the past climate than the spot measurements provided by other methods such as study of tree-rings or air bubbles trapped in glaciers. Reports in the local press, municipal and church records, private documents and estate registers provide a mine of information about meteorological conditions, unusual occurrences and crop yields. Research has already been carried out in six European archives to identify documents containing climatic data for the period 1725 to 1775.

COMMENTARY *by Federico Mayor*

This article is one of a series in which the Director-General of UNESCO sets out his thinking on matters of current concern

Towards education for all

NEXT November, the Heads of State or Government of nine large countries will meet in New Delhi in India to give a new impetus to their efforts to achieve education for all. There is an obvious and powerful logic in this initiative. The nine countries—Bangladesh, Brazil, China, Egypt, India, Indonesia, Mexico, Nigeria and Pakistan—collectively account for nearly three-quarters of the world's adult illiterates and a sizeable share of the world's out-of-school children. Thus there can be no significant overall progress in education unless there is progress in these countries. They are, so to speak, the key to the solution of the problems of illiteracy and lack of education. If Education for All progresses in these countries, it progresses for the world as a whole. If it lags in these nations, or even in certain of them, world statistics will reflect this failure. These countries, therefore, have a special responsibility to the world community—a responsibility, I should add, of which their governments and peoples are keenly aware.

These nine nations are facing enormous challenges which are linked among other things to their size, cultural diversity and disparities in wealth. But they are, at the same time, nations with vast potential, nations which excel in countless areas, traditional and technological alike. Not only do they have problems; they have, in differing degrees, the means to cope with them. They are thus seen by their neighbours not only as examples, but also as nations which are capable of extending a helping hand, and in many cases they are already doing so. They are fully capable of serving as regional and world laboratories and resources in the quest to bring education to all the world's citizens. The dynamism and the weight of the expertise they possess, not just their sheer size, give high promise and potential to this initiative.

Several of these countries are the cradles of great civilizations. They invented writing systems and used them to record many of the most momentous and meaningful chapters in the human adventure. Their progress is thus of the highest symbolic value. At a moment when our faith in the human vocation is being sorely tried, when our optimism is daily challenged by the follies and tragedies that beset us, how splendid it would be to see these nations where civilization was born lead the world into a new era of hope and enlightenment.

A UNIVERSAL MOVEMENT

UNESCO attaches the highest importance to the initiative of these large countries and will lend it all possible support. But the Education for All movement is not limited to any one group of countries. It is a worldwide undertaking in which all nations, the richest as well as the poorest, have a right and duty to participate. At the World Conference on Education for All, held at Jomtien (Thailand) in March 1990, the developing countries pledged to concentrate and accelerate their efforts to achieve this goal, while the industrialized countries undertook to lend considerably increased support to such efforts. Initially, it was the sponsoring agencies—UNICEF, the United Nations Development Programme, the World Bank and UNESCO—that mobilized themselves and made education for all their priority. But there is now clear evidence that bilateral agencies are joining actively in this initiative and providing new resources. Thus it is with great pleasure and satisfaction that I can report to you that the alliance forged in Jomtien three years ago has become a worldwide movement in which a growing number of countries and organizations are actively engaged.

This progress must, of course, be taken as an incentive and not as a reason for complacency. In an age of slogans, it is important to remind ourselves constantly that "education for all" is a message with a real and urgent meaning and a goal that is within our reach, if we firmly resolve to achieve it. But let there be no doubt that the outcome is still very much in question. Nothing will be more decisive in determining it than the progress made in these nine large countries. If they succeed in transforming education for all from a slogan to a reality, I am certain that rapid progress will follow elsewhere and that the world will enter the twenty-first century prepared for a new age of enlightenment. ■

RECENT RECORDS

TRADITIONAL MUSIC

MEXICAN INDIAN TRADITIONS
Celebrations: 500th Anniverary of the Encounter between Two Worlds
UNESCO Collection, Audivis
CD D 8304

This live recording, made in France at the 1992 Avignon Festival, features the rarely-heard music of the Totonac, Zapotec, Seri, Mayo and Tepehuan peoples of Mexico, whose histories are recalled in several of the songs. Accompanied by rattles, handclaps and other percussive effects, these are often monodic and have a fixed, almost unvaried rhythmic pattern. Some pieces featuring horns recall the sound of brass bands, though with a touch of fantasy for some notes are untempered. The dance of the Negritos from Veracruz, probably inspired by Mexico's black population who live principally in the Veracruz and Guerrero regions but have a relatively low profile in Mexican folklore and ethnology, is particularly rhythmic; violin and guitar come together to suggest American country or Tex-Mex music. The groups featuring cowbells, fifes and hand-drums, on the other hand, recall traditional Provençal music.

SULLY CALLY. *Damyé*
Traditional music of Martinique. The Roots People, vol. I
Paroles de Tambours CD SC92

Sully Cally, a percussionist, actor and musicologist from Martinique, recently published a book packed with information about his country's traditional music. On this compact disc, essential listening to go with the book, Cally plays a *damyé* drum with *ti-bwas* (*petits bois* or "little wood") which are struck on the side of the drum to create an additional rhythm. He is accompanied by several singers and the *bel-air* (*bélé* in Creole) drum-playing of José Couf. The *bel-air* musical tradition of Martinique and that of *gwo-ka* in Guadeloupe resemble Haitian music with its strong African influence. Although it is today enjoying a come-back in the Caribbean, it is still less well-known elsewhere than the more Europeanized and sometimes insipid beguine. Buy this record to hear marvellous Creole songs and powerful rhythms that have lost none of their earthy authenticity.

CLASSICAL

PAGANINI. *24 Caprices*
Patrick Gallois (flute)
Deutsche Grammophon CD 435 768-2

This recording of Paganini's *Caprices* transcribed for the flute by the young French flautist Patrick Gallois is a *tour de force*. Gallois, with his birdlike tone, has virtuosity, pitch, energy—all the qualities necessary to interpret these difficult pieces, with their abrupt chromatic leaps. On some tracks he sings into his flute as he plays, a technique that is used by jazz musicians like Yusef Lateef but is much less common in classical music. Gallois writes in the sleeve-notes that "Performing Paganini's *Caprices* taught me to transcend the flute. . . . Flautists should 'forget' the flute, they should be forced to abandon the beaten track." One can only imagine the effort it cost him to achieve so transparent a tone, as though we were listening directly to his breathing, with no instrument interposed.

MOZART. *The Last Three Symphonies: 39, 40 and 41 ("Jupiter")*
The Chamber Orchestra of Europe, conducted by Nikolaus Harnoncourt
CD Teldec 9031-74858-2

Recorded live in Vienna on 5 December 1991, the 200th anniversary of Mozart's death, this is a magisterial performance of Mozart's last three symphonies, all written in a six-week period of 1788 during the composer's stay in the city. Harnoncourt, a 'cellist turned conductor, brings out all their elegance and musicality. The phrasing is perfect, and the melodic flow is as ample as one could wish. This is a classic recording any collector would treasure as a standard by which to judge others.

BACH. *Tocaten und Fugen BWV 538, 566, Praeludium und Fuge BWV 535, Orgelbüchlein BWV 618-632*
Marie-Claire Alain (organ)
Erato CD 2292-45701-2

Marie-Claire Alain here plays Bach on an organ built by Gottfried Silbermann in 1714 for the Cathedral of Freiberg. The notes are unevenly tempered, as would have been the case in Bach's day, and according to Alain the sound of the organ dictated the choice of material. The music unfurls vibrantly and takes majestic flight, imbued with intense emotion. Few composers have communicated religious passion so well and with such musical rigour.

JAZZ

MONK
Thelonious Monk (piano), Charlie Rouse (tenor sax), L. Gales or Butcha Warren (bass), Frankie Dunlop (drums)
Columbia CD 468407-2

Another Monk masterpiece reissued by Sony Music in its Jazz Originals collection, this CD features such standards as "April in Paris" and "I Love You", recreated from scratch by the pianist as solo setpieces, as well as some lesser-known original compositions including "Teo" and "Children's Song". Monk devises extraordinary harmonic progressions on "Liza", while his original way of stressing notes is in evidence on "Children's Song", "Just You and Me" and "Teo". He is well served by the backing group and especially by Charlie Rouse, whose sound here is particularly velvety.

DONALD BYRD. *A City Called Heaven*
Donald Byrd (trumpet, flugelhorn), Joe Henderson (tenor sax), Bobby Hutcherson (vibes), Donald Brown (piano), Rufus Reid (bass), Carl Allen (drums), Lorice Stevens (vocals)
Landmark LCD 1530-2

This fine CD by Doctor Donaldson Toussaint L'Ouverture Byrd (to give him his full name) was recorded in July 1991 with a group of high-quality backing musicians. "King Arthur", in march time, recalls Art Blakey's "Blues March". Byrd uses a mute for the thoughtful "I'll Always Remember". Lorice Stevens sounds a little like Abbey Lincoln in "A City Called Heaven"—a traditional air Byrd handles modally—while there is a positively Elizabethan quality to her singing on "Remember Me", inspired by Purcell's *Dido and Aeneas*. Bobby Hutcherson's poignant "Del Valle", played as a waltz, contrasts with the more complex and abstract "Not Necessarily the Blues".

ISABELLE LEYMARIE ■

referred to earlier, which are one of the aspects of *brahman*, involves linking similar elements from the different levels of existence. There are not just two of these, but more often three: the level of the gods, which is that of the cosmos; the level of the individual human being (body and soul); and, between the two of them, the ritual level. A ritual object, a particular moment in a ceremony, is thought to have a replica or counterpart in some specific spatial or temporal element of the universe, and also in some aspect of human activity or an organ of the human body.

This network of correspondences is not static. The Vedic authors, particularly in the *Upanishads*, give much thought to finding new, more refined and complex equivalences. Several Sanskrit words convey this idea, words that mean "connection", "link", even "kinship". In Vedic India the idea of correspondences is more important than the concept of causality—whereas Buddhism insists on the sequence of cause and effect. Louis Renou admirably clarified the difference between Vedism and Buddhism on this point in one of the articles collected in his book *L'Inde fondamentale*, which came out in 1978.

■ ***What differentiates Hinduism from the Vedic religion?***

—We've already noted the differences with relation to the nature and status of the holy writings. If we turn to religious beliefs and practices, and first and foremost to the pantheon of gods, we find that some Vedic gods survive into Hinduism, though in a weaker and more obscure form, while others disappear completely. On the other hand, gods that play only a secondary role in the *Veda* move to centre-stage. Vishnu and Shiva are the principal Hindu gods, co-existent and venerated by all believers. But Hindus divide into "sects" devoted to different aspects of Vishnu or Shiva, for another important characteristic of Hinduism is that there are an infinite number of divinities, but each is a special manifestation of one of the principal gods.

This is where the doctrine of avatars comes in. At different times, depending on the cosmic problems he had undertaken to resolve, the god Vishnu made himself manifest by "descending" to Earth in various guises, while always remaining himself. Each of the personalities he adopted, and there are canonical lists of these, has a mythology built around it and is the object of a specific cult. Rama and Krishna, for example, who are both gods and heroes, are among the avatars of Vishnu. It is extraordinary that these avatars, destined to intervene in cosmic eras earlier than our own, are still the object of fervent devotion today. I would also point out that the theory of cosmic cycles, and the division of each cycle into a similar number of successive eras separated from one another by catastrophes, is also a Hindu innovation.

Unlike the Vedic gods, who are primarily receivers of offerings, the Hindu gods are seen as beings with whom humans can have an intense emotional relationship. One of the most remarkable aspects of Hinduism is the appearance, in about the sixth or seventh century A.D., of the concept of *bhakti*, or fusional devotion, according to which worshippers seek to be absorbed into and fused with the divinity they adore. Unity with the god is the expected outcome of the love they bear and the grace they hope for.

The Hindu conception of divinity is both the cause and the effect of forms of worship that are unknown to the *Veda*. In Hinduism gods are represented by images—or, more accurately, they are present, alive and active, in the images that represent them. These images are permanently housed in sanctuaries or temples, clearly defined places where they are the masters.

The gods are present in every image of themselves, but this presence has different degrees of completeness and intensity, so that there is a kind of hierarchy among images. Worship consists of treating the image as a living person whom one can contemplate, revere and care for, and whose goodwill one hopes to win. In Hinduism devotion to the image of a god in his sanctuary or temple occupies the place that the sacrificial rite held in Vedism. Not that Hinduism did away with sacrifices entirely; it shifted them from the centre of life and religious thought and gave them a secondary role.

■ ***What is asked of the Hindu gods?***

—The things of this world, first and foremost: health, prosperity, above all offspring. Wisdom and all kinds of success. On a wider scale, the gods are expected to provide good harvests, the normal round of the seasons, order in society and the world. But also personal salvation in the after-life. And this raises the question of what salvation is and what it is that one needs to be saved from. The answer is: from unpleasant forms of life after death. People want to avoid hell and go to heaven. Such a desire was already expressed in Vedism. When Hinduism emerged, however, a new concept was added, and that was the famous doctrine of *karma* (or *karman*).

The idea is that people are caught up in an endless stream of successive lives. Death is simply the unending passage from one life to the next. The type of existence a person enters at the end of each life is determined by his or her actions in previous lives. Which is to say that we always have the life we deserve. If it is pleasant, it is to allow us to enjoy the fruits of meritorious acts accomplished in some previous existence. If it is disagreeable, it is the result of bad deeds committed in past lives.

One's *karma* or stock of acts is of course constantly renewed, as long as one passes through lives in which taking action of some sort is unavoidable. But Indian Hindus see the necessity of rebirth in a series of lives that are always deserved, through the workings of an autonomous mechanism, as a misfortune or rather as a state of subjection from which they seek release. Salvation in the context of *karma* is not a matter of seeking to obtain a happy life in a heavenly abode after death, for such a destiny would itself inevitably be temporary. Real salvation lies in deliverance, the possibility of reaching the end of this mechanism and so concluding the process of rebirth.

Tenth-century sculptures at Chamba, Himachal Pradesh state (India), show the god Shiva and his consort Parvati.

■ *How can this be brought about?*

—It can only be achieved by individuals who have exhausted their *karma* by various methods that involve on the one hand a very difficult process of mental awakening and on the other various kinds of asceticism. As to the condition of those who achieve deliverance and the attitude to be adopted towards them, different schools have different views, though none has very much to say on the matter. In popular Hinduism, however, deliverance is thought to lead to eternal happiness, which is another blessing expected from the gods, or more accurately from the god one entrusts oneself to in *bhakti.*

In speaking of Hinduism I have concentrated on what distinguishes it from Vedism, and I have also stressed the great diversity of beliefs, doctrines and forms of worship contained within it. But I should also point out that from a different viewpoint what is striking is the continuity of certain fundamental principles that are always present. These include the idea that there is an order that englobes nature as well as society. The division of society into "classes" is not a human institution but a fact associated with the structure of the cosmos. Since the individual soul subjected to the laws of *karma* passes not only through human existences but also those of animals and gods, one might well ask if there is anything special about the role humankind plays in the cosmos. In fact it is distinguished from all the other life-forms by the fact that only humans act in such a way as to produce *karma.*

■ ***Buddhism is thought to have emerged from Brahmanism around the fifth or sixth century B.C. What are the links, and the differences, between Brahmanism and Buddhism?***

—It is by no means certain that Buddhism did grow out of Brahmanism, nor that it should be explained as a deviation or an innovation in relation to a pre-exisiting Brahmanic faith, even though this is often said. It might be more accurate to think that Buddhism is rooted in the religious traditions of the eastern part of the Ganges Valley, a region which was perhaps not exclusively given over to Brahmanism.

It is true nevertheless that the Buddhist texts presuppose the existence of Brahmanic society and religion and are in fact a critique of certain Brahmanic concepts. But the fact that the Brahmanic texts are in Sanskrit, while the earliest Buddhist texts are in Pali, a Middle Indo-Aryan language, is evidence of early Buddhism's autonomy of Brahmanism.

The distinctive characteristic of early Buddhism seems to be the belief that suffering is ever-present, and that it is linked to the impermanent nature of things. One has to become aware of suffering, recognize its causes and discover the means of deliverance from it. From that flows a sentiment of universal compassion, and a critique of both the Brahmanic rites and the pretentions of the brahmans, the masters of ritual. Then again, Buddhism is the creation of a human founder who lived in a known time and place. The story of his life, his ordeals, the way he was "illuminated" by the truth, his efforts to build up the community of his first disciples—all these events make up a story that is an essential part of Buddhist doctrine.

■ ***Without forcing the comparison, what would you say about the similarities and differences between Vedism and Hinduism and the religions of the Book?***

—I wouldn't overemphasize the gap between Indian polytheism and the monotheism of the religions of the Book. There is a difference, obviously, but stressing it tends to lead to oversimplification. On the one hand one could point to the divine plurality of Christianity; on the other to the idea, so often repeated by Hindus, that all their countless gods are only aspects of a single God. What seems more important to me is that for the religions of the Book, human beings are radically different from the rest of creation. Humanity is destined to have a history, and that history is oriented and punctuated by successive moments of revelation. We've seen that in Vedism and Hinduism humanity and society cannot be said to have existed before the event of revelation—and that revelation cannot even properly be described as an event. In my view, the most significant difference between the two groups of religions lies in this relationship to time. ❐

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Theme of the next issue (June 1993):

MINORITIES

Also featuring an interview with the Italian writer and semiologist

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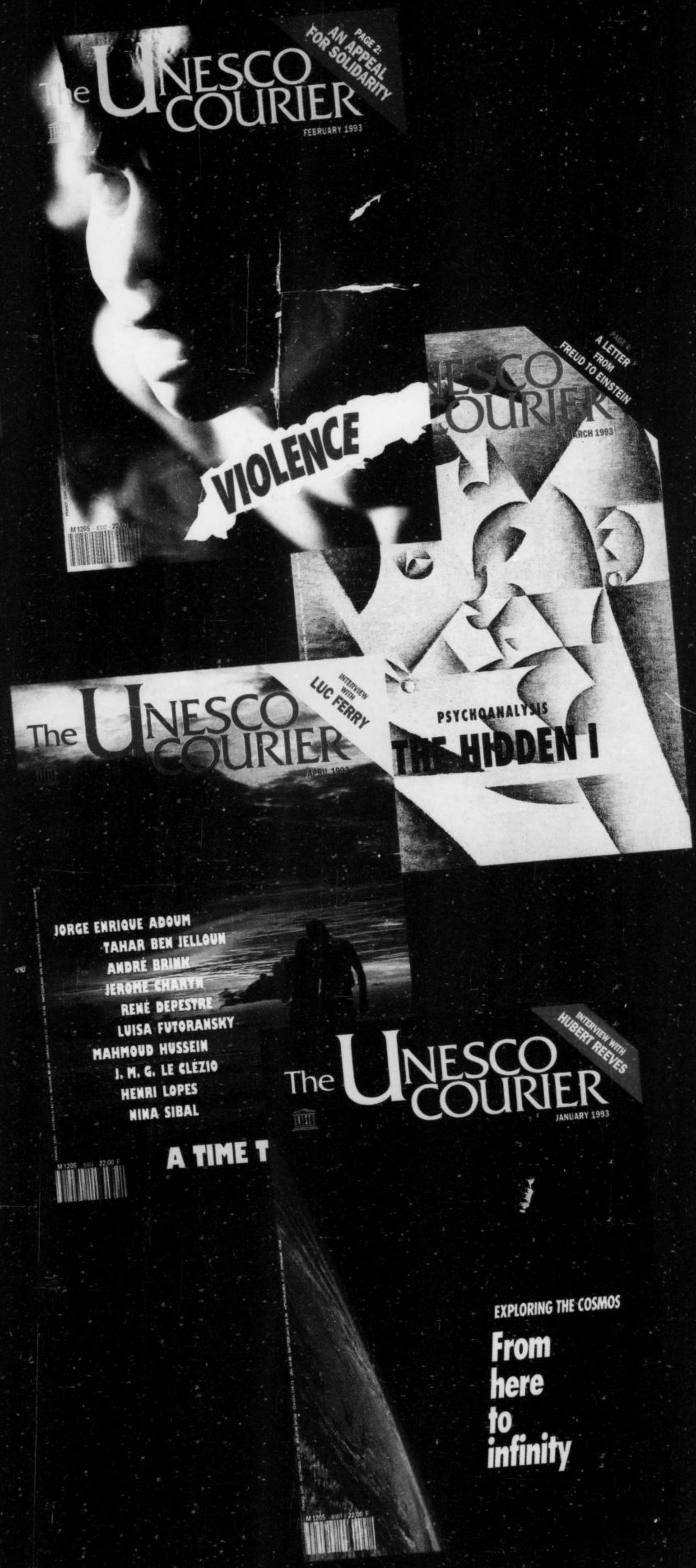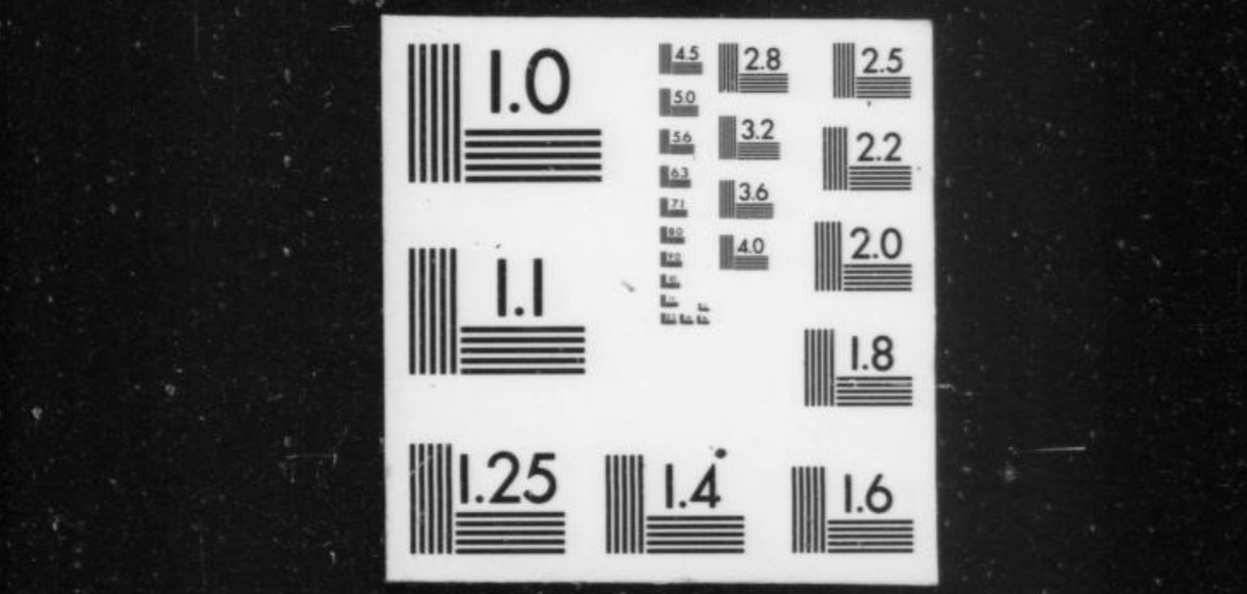
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